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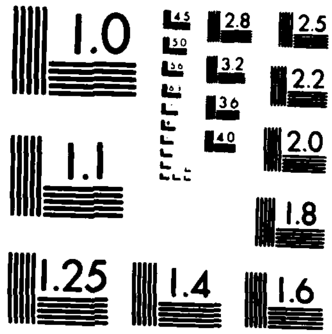

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GLOBAL POSITIONING SYSTEM - A MODIFICATION
TO THE BASELINE SATELLITE CONSTELLATION
FOR IMPROVED GEOMETRIC PERFORMANCE

THESIS

David W. Thomin
Captain, USAF

AFIT/GA/ENG/84D-4

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

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GLOBAL POSITIONING SYSTEM - A MODIFICATION TO THE BASELINE SATELLITE CONSTELLATION FOR IMPROVED GEOMETRIC PERFORMANCE

THESIS

Presented to the Faculty of the School of Engineering

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Astronautical Engineering

David W. Thomin, B.S.

Captain, USAF

December 1984

Approved for public release; distribution unlimited

Preface

The purpose of this study was to investigate the geometric performance of a modification to the proposed baseline constellation for the NAVSTAR Global Positioning System (GPS). To assist in the evaluation, a computer program developed by the **Rand Corporation** (17) was obtained and modified for use in analyzing the geometric performance of this pseudoranging navigation satellite system. The geometric performance of the currently proposed baseline constellation was analyzed using this tool and was compared with the performance of the modified constellation. Although additional factors still need to be considered in selecting the optimum satellite constellation, the modification presented here greatly reduces the percentage of system outages that occur due to the poor geometry of available satellites and, at least on the surface, appears to provide a significant improvement over the present proposal. Perhaps more importantly, it suggests that the expectation of Walker (22:4) that "continuous whole-Earth coverage would be provided most effectively by a system in which the distribution of satellites over the Earth's surface was maintained as uniform as possible," is *not necessarily true*. Since practically every analysis to date has assumed Walker's "expectation" as a basis for comparing constellations, the results of this study could prove to be of significant value in future analyses.

I have had help from many individuals in this thesis effort, and would like to express my thanks to all of them. In particular, I would like to thank Ms. Sandy Berning (AFWAL/AAAN-3), for her assistance in obtaining access to several computer files, to Dr. John Weaver (ASD/ENSSE), for his aid in modifying and debugging the computer program used in my analysis, and to Professor C.R. Edstrom (AFIT Math Department), for his assistance in understanding the mathematical concepts involved.

I extend my deep appreciation and special thanks to Dr. George M. Siouris for his extensive

guidance as my thesis advisor, for the special interest he showed in my work, and for all the encouragement he provided me throughout the many months of effort involved. Finally, I wish to thank my wife Jeannette for her patience and understanding during the course of my graduate program, and to my sons, James and Michael, for sacrificing many hours of each day that they could have shared with me while I worked on this thesis.

David W. Thomin

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Abstract

This investigation determined the effect of changes in eccentricity to the orbits of the proposed Global Positioning System (GPS) 18-satellite baseline constellation by analyzing the geometric performance obtained. The effect of satellite losses upon global coverage was also examined with an emphasis on determining which combination of remaining satellites provided the best and worst cases. The potential of GPS for navigation of the space-based user was explored by analyzing the geometric performance obtained for a variety of user trajectories and GPS antenna beamwidths. A computer program which analyzes the many aspects of the geometric performance of pseudoranging navigation satellite systems was used for the analysis.

The results of this analysis indicate that a simple modification to the baseline constellation could reduce system outages on a global basis by nearly 50%. The modification consists of changing the shape of the GPS circular satellite orbits to slightly elliptical ones, resulting in more favorable satellite geometry and fewer outages to the user on a global average. Further consideration to determine its feasibility was recommended. The degradation of coverage due to satellite losses was found to be largely dependent on the combination of the remaining satellites, and suggests that rephasing the remaining satellites could significantly improve the degraded performance. The potential for conventional use of GPS for navigation in space was shown to exist for the low altitude user, but will be very limited for the higher altitude user due to the present GPS antenna design. Increasing the designed antenna beamwidth was shown to significantly improve performance for the high altitude user. It was recommended that this modification be considered in future GPS antenna design, if conventional GPS navigation is to be desired for the high altitude space user.

GLOBAL POSITIONING SYSTEM - A MODIFICATION TO THE BASELINE SATELLITE CONSTELLATION FOR IMPROVED GEOMETRIC PERFORMANCE

I. Introduction

The Navstar Global Positioning System (GPS) is a space-based, pseudoranging navigation satellite system that will provide worldwide, nearly continuous, three dimensional position, velocity, and coordinated universal time to the suitably equipped user (2:226). Although designed primarily for global navigation of a terrestrial or near-earth user, the potential exists for expanding its use to the space-based user. This study analyzes the geometric performance of the proposed baseline orbital constellation not only for the earth-based user, but for the space-based user as well. In addition, the effect on geometric performance of modifying antenna beamwidth is examined for a variety of space-based user trajectories, including both low and high altitude orbits , intermediate transfer orbits, and typical ICBM trajectories. The effect of satellite losses on geometric performance and system accuracy is examined with a special emphasis on the 'best' and ' worst' case scenarios.

The position accuracy available from GPS can be divided into two multiplicative factors: position dilution of precision (PDOP) and other "system" errors (17:1). The "system" errors depend on the accuracy of the ephemeris data and transmitted time from the satellites, ionispheric and atmospheric effects, and various other error sources as indicated in Table I. Since the PDOP factors depend predominantly on the user/navigation satellite geometries, they can be analyzed

independently of system errors, which depend on a multitude of factors. This characteristic allows separate analyses of alternative orbital configurations, user motion, and satellite losses sustained for the purposes of comparison and choosing the optimal constellation (17:3).

TABLE I

GPS Error Budget (2:228)

ERROR SOURCE		ERROR CONTRIBUTION (METERS) L_1/L_2 P-Code	L_1 C/A Code
Space & Control Segments	Clock & Navigation Subsystem Stability	2.1 (1-Sigma)	2.7 (1-Sigma)
	Predictability of Satellite Perturbation	1.0	1.0
	Ephemeris Prediction & Model Implementation	2.5	2.5
	Other	0.7	0.7
User Equipment	Ionospheric Delay Compensation	2.3	10.0
	Tropospheric Delay Compensation	2.0	2.0
	Receiver Noise & Resolution	1.5	15.0
	Multipath	1.2	1.2
	Other	0.5	2.0
Ranging Error = RSS Total 1-Sigma		5.3	18.7
3D RMS Navigation Error = (PDOP RMS) (Ranging Error) = (3.7) (Ranging Error)		19.6	69.2
3D Spherical Error Probable = (0.8) (3D RMS)		15.7	55.4

After fully analyzing the geometric performance of the proposed baseline constellation, a modification to this constellation will be incorporated and then be analyzed for comparison. This modification will "target" the geographic areas of weaker coverage in an attempt to reduce the number and length of system outages that occur (due to poor geometry) on a global basis by

changing the eccentricity of the six orbital planes and selectively positioning the periapsis point of each orbit. As the primary tool for the analysis, a computer program on the geometric performance of pseudoranging navigation satellite systems, developed by the **Rand Corporation** (17), was obtained and modified for this purpose. (For more information on the computer program and its operation, see Appendix B).

In order to better understand the significance of the geometric performance of each constellation and its effect on system accuracy, a thorough review of the terminology and GPS concept of operation is necessary. Therefore, Chapter II will be devoted to providing the background necessary for understanding the system concepts involved. The mathematical derivations for the navigation equations will be presented in Chapter III, and the dilutions of precision (DOPs) will be defined and related to overall system accuracy.

Chapters IV and V will be devoted to the data analysis for both the proposed baseline constellation and the modification to that constellation. The geometric performance of each constellation will be directly compared with that of the other, and from this comparison, conclusions and recommendations will be made and presented in Chapter VI.

To further assist the reader in understanding the information contained in this report, a glossary of technical terms is provided in Appendix A. Appendix B provides an explanation of the variables and subroutines of the computer program utilized in the analysis and explains the modifications that were incorporated. The complete computer program listing is provided in Appendix C, followed by samples of the program output (Appendix D) and selected data extracts (Appendix E) from the more than 150 computer runs made during this evaluation.

II. System Concept

Background

Since the early 1960's, the idea that navigation and positioning could be accomplished using radio signals transmitted from satellites has been actively pursued by both the Navy and the Air Force. Each service separately established its own concept of such a system through an extensive program of studies and tests designed to demonstrate the feasibility of a space-based positioning and navigation system (19:21.1.1). The success of the Navy Navigation Satellite System, better known as TRANSIT, stimulated both the Navy and Air Force to develop a more advanced system that would provide enhanced capabilities and global coverage. The Navy's concept, TIMATION, was essentially a two-dimensional system and could not provide position updates in a high-dynamic aircraft environment. The Air Force concept, Program 621B, could provide the high-dynamic capability but had its own shortcomings as well, particularly from a survivability standpoint (10:1177).

Recognizing the need to integrate these systems, the Deputy Secretary of Defense issued a memorandum in 1973 which designated the Air Force as the primary agency to develop, test, and deploy a single system that could best serve the needs of the defense (19:21.1.1). A system concept which combined the best features of both programs, designated the Navstar Global Positioning System, was the resulting system design. Management of the Navstar GPS was assigned to the Joint Program Office (JPO) located at Space Division in Los Angeles.

When first conceived, the design for the fully operational system consisted of a total of 24 satellites, deployed with eight satellites uniformly distributed in each of three orbital planes, providing continuous three-dimensional global coverage with predicted accuracies in the ten meter range (10:1177). In 1978 and 1979 Defense budgetary constraints forced a reduction in

funding for the GPS program. As a result, in 1980, the Navstar GPS program was restructured and the number of satellites for the fully operational system was reduced from the 24 originally planned to 18. Exhaustive studies have been made since that time to establish the optimum orbital configuration for these remaining 18 satellites. System accuracy, survivability, satellite visibility, ease of buildup, location and duration of outages, ease of sparing and replacement, and growth potential of the constellation to 24 satellites were considered in the selection of what is now the baseline constellation, which will consist of 18 satellites, uniformly distributed in six orbital planes with three satellites per plane, and will provide nearly continuous world-wide coverage that optimizes accuracy over the primary areas of interest (15: E9.3.1).

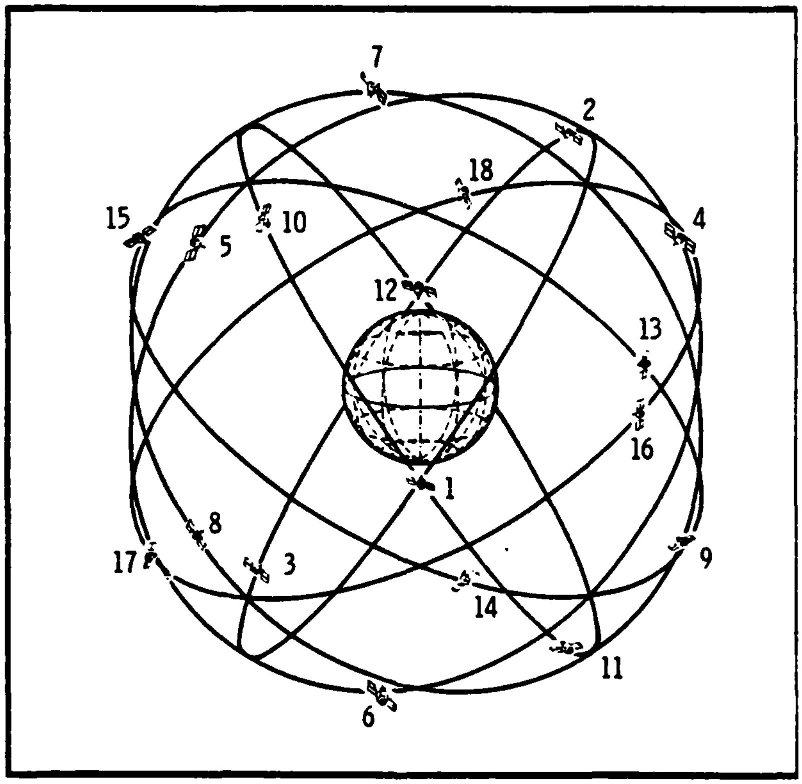

Figure 1. The Six-Plane, 18-Satellite Baseline Configuration (15:E9.3.2)

Navstar System Overview

The Navstar Global Positioning System (GPS) is composed of three segments as described below (Figure 2):

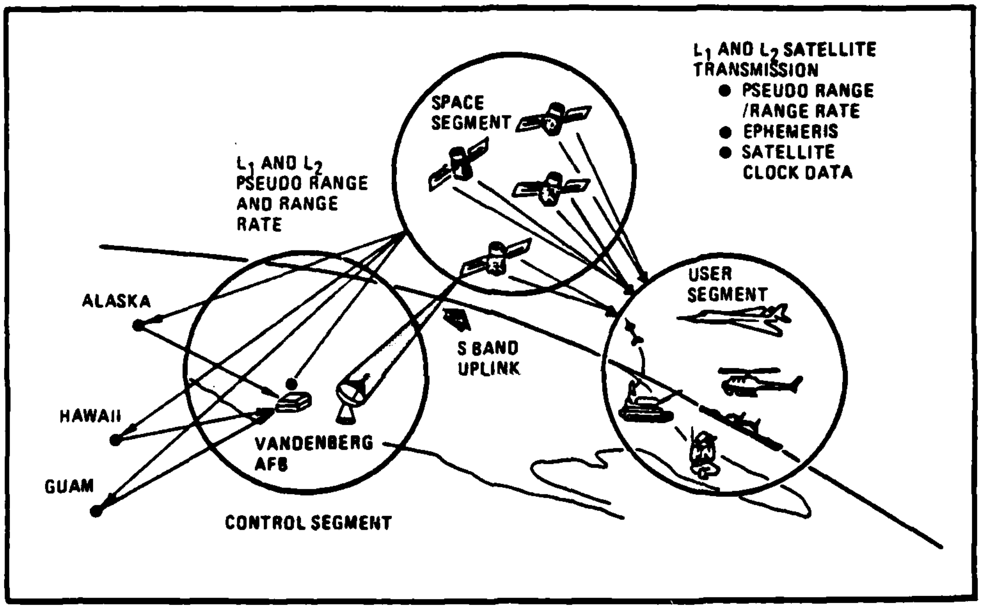

Figure 2. Navstar GPS Segments (6:218)

Space Segment. Designed to be fully operational in late 1988, the orbital constellation will consist of 18 satellites deployed in circular, 12 hour orbits of 26,600 km radius (10,900 nautical mile altitude). The satellites will be uniformly spaced (120^0 apart) with three satellites in each of six orbital planes, each orbital plane inclined at 55^0 to the equator. Each orbital plane

will be separated from each other in longitude by 60^0. Relative phasing of the satellites from one orbital plane to the next is 40^0, which simply means that when an ascending satellite in one plane is crossing the equatorial plane, an ascending satellite in the adjacent plane to the east is 40^0 above the equatorial plane in its own orbital plane (15:E9.3.1). Each satellite transmits navigation signals at frequencies of 1575.4 MHz and 1227.6 MHz, which contain navigation data such as satellite ephemeris and satellite clock bias information (2:227). Use of the two signals permits the user's equipment to compensate for the ionospheric group delay or electromagnetic disturbances in the atmosphere which may alter the affected signals (19: 21.1.1). Each satellite has a mean mission duration of 6.2 years and a design life of 7.5 years (15: E9.3.7), and the present design provides for the placement of three additional satellites within the constellation to act as active, in-orbit, replacement spares.

<u>Control Segment</u>. The Ground Control Segment monitors the broadcast satellite signals and uplinks corrections to ensure predefined accuracies. The operational control segment will consist of five monitor stations, a master control station, and three uplink antennas. The widely separated monitor sets, positioned worldwide, will allow simultaneous tracking of the full satellite constellation and will relay orbital and clock information to the master control station (2:226). The ranging data accumulated by the monitor stations will be processed by the Navstar Operations Center (master control station) for use in satellite determination and systematic error elimination (19: 21.1.1). The master control station then forms corrections that are uploaded to the satellites by the uplink antennas (2:227).

<u>User Segment</u>. The User Segment selects the four, best positioned satellites from those visible and, using the navigation signals passively received from each of these satellites, the user's receiver measures four independent pseudoranges and pseudorange rates to the satellites. The receiver/processor then converts these signals to three-dimensional position, velocity, and

system time. The position solution is in the World Geodetic System Coordinates (WGS-72), an earth-centered, earth-fixed coordinate system, which can be converted to any other coordinate system the user desires (19:21.1.2).

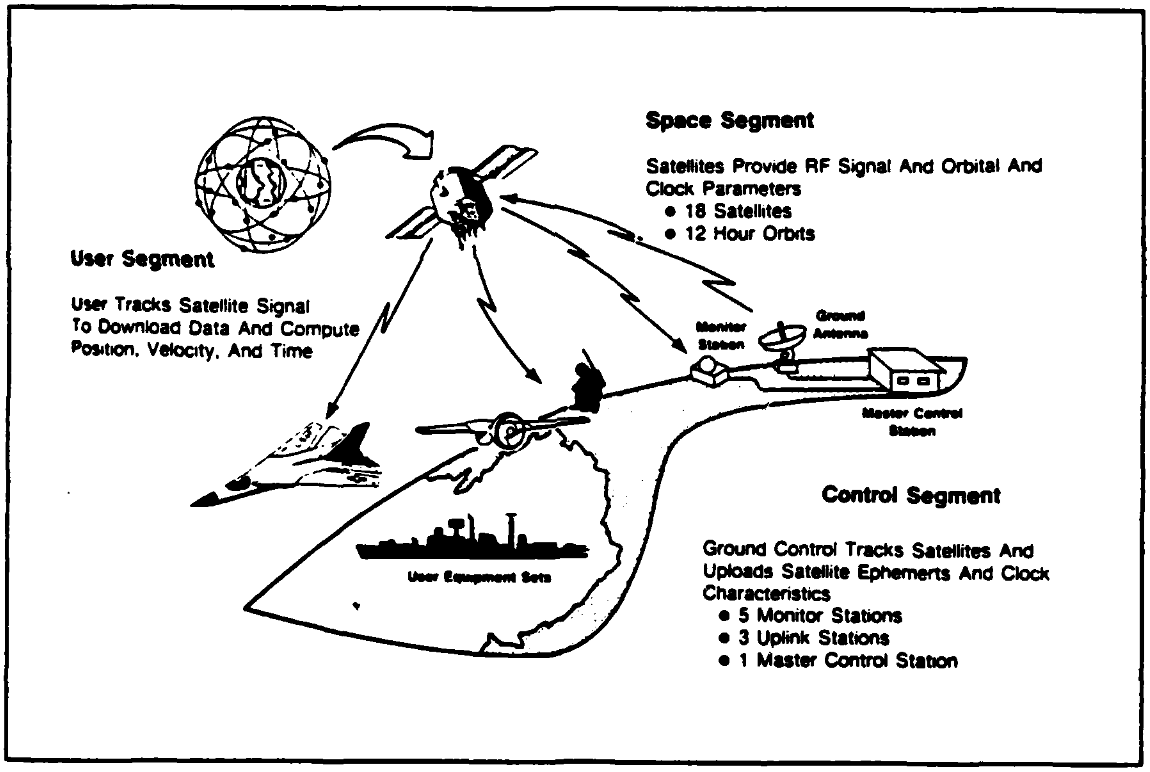

Figure 3. GPS Concept of Operation (2:227)

Concept of Operation

With 18 satellites, if the user is able to receive the navigation signal from satellites above a five degree elevation angle, there are always four or more satellites available for use. (The limit on elevation angle is due to terrain masking, line -of-sight obstructions, etc.) GPS satellites continuously transmit navigation signals at two L-band carrier frequencies: L1, at 1575.42 MHz and L2, at 1227.6 MHz. L1 is modulated by a Coarse/Aquisition (or C/A) code and a Precision (or P) code, whereas L2 contains either the P or C/A code but not both; the P-code is normally used. In addition, superimposed on both frequencies is system data at 50 bits per second that provide handover information from the C/A to P-code, satellite orbital characteristics, satellite health satatus, and satellite clock errors (2:227). Comparison of the delay between the two signals allows for proper computation of errors due to ionospheric propagation or electromagnetic disturbances in the atmosphere (19:21.1.1).

Navigation using GPS is accomplished by passive triangulation. To obtain a navigation solution, the user measures "pseudorange" to each of the four satellites by timing the received pseudorandom code epoch with respect to his local estimate of time. The term "pseudorange" is used since the timing measurement of true range to the satellite contains an error in the form of a yet undetermined clock bias. The position of the four satellites is computed using the received ephemeris data. Using this data and the pseudorange measurements, the user then solves four equations in four unknowns to determine his three-dimensional position and precise time. Three-dimensional velocity is determined by measuring the doppler shifts on the received carrier frequency (2:227).

III. Navigation Equations

The Navigation Solution

In order to develop the navigation equations used in solving for the user's three-dimensional position and time, we will utilize the earth-centered, right-handed, Cartesian coordinate system as illustrated in Figure 4. At time zero, the X-axis passes through the intersection of the equatorial plane and prime meridian, the Z-axis passes through the North Pole, and the Y-axis completes the right-handed orthogonal system. Because of the earth's rotation, the x and y coordinates are constantly changing in longitude with time.

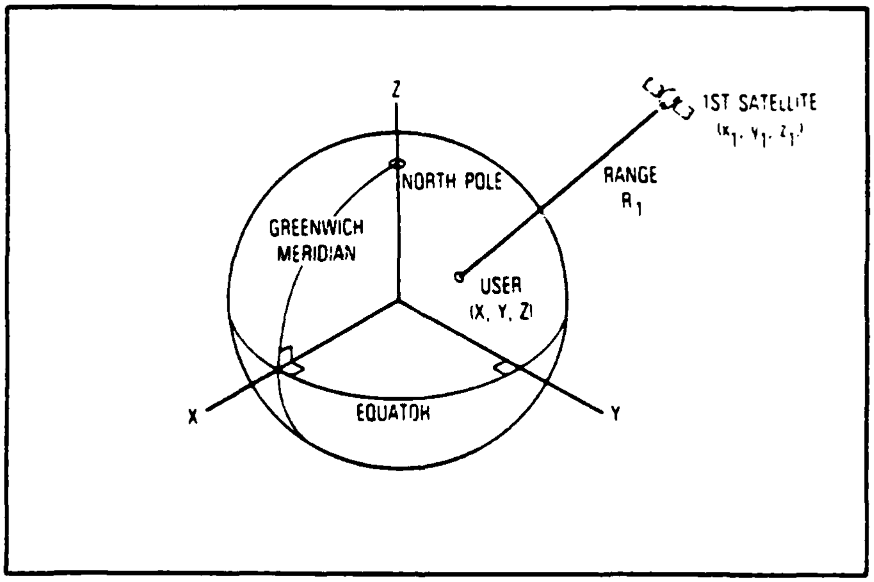

Figure 4. Earth-Centered Inertial Frame (14:97)

The basic nonlinear equations using four satellites are

$$[(x-x_i)^2 + (y-y_i)^2 + (z-z_i)^2]^{1/2} + T = R_i \qquad (1)$$

where

x_i, y_i, z_i = position of the ith satellite (known)

x, y, z = user position (unknown)

T = clock bias (unknown)

R_i = pseudo range measurement to the ith satellite

The quantities R_1, R_2, R_3, and R_4 are "pseudoranges" in that they are the sum of the actual range displacements plus the offset due to user time error. Although these equations can be solved directly, user equipment employs a much simpler version of these equations which can be derived by linearization methods as follows (14:97):

Let

x_n, y_n, z_n, T_n = nominal (a priori best estimate) values of x,y,z, and T

$\Delta x, \Delta y, \Delta z, \Delta T$ = corrections to nominal values

R_{ni} = nominal pseudorange measurement to ith satellite

ΔR_i = residual (difference) between actual and nominal range measurements

Thus we obtain the following incremental relationships:

$$x = x_n + \Delta x$$

$$y = y_n + \Delta y$$

$$z = z_n + \Delta z$$

$$T = T_n + \Delta T$$

$$R_i = R_{ni} + \Delta R_i$$

and

$$R_{ni} = [(x_n - x_i)^2 + (y_n - y_i)^2 + (z_n - z_i)^2]^{1/2} + T_n$$

Substituting these incremental relationships into (1) we obtain

$$[(x_n + \Delta x - x_i)^2 + (y_n + \Delta y - y_i)^2 + (z_n + \Delta z - z_i)^2]^{1/2}$$

$$= R_{ni} + \Delta R_i - T_n - \Delta T_i \qquad (2)$$

Working with the left hand side of the equation and expanding terms we obtain

$$[(x_n + \Delta x - x_i)^2 + (y_n + \Delta y - y_i)^2 + (z_n + \Delta z - z_i)^2]^{1/2}$$

$$= [(x_n - x_i)^2 + 2\,\Delta x(x_n - x_i) + (\Delta x)^2 + (y_n - y_i)^2 + 2\,\Delta y(y_n - y_i)$$

$$+ (\Delta z)^2 + (z_n - z_i)^2 + 2\,\Delta z(z_n - z_i)^2 + (\Delta z)^2]^{1/2} \qquad (3)$$

Rearranging terms and eliminating second order terms, this expression can be written simply as

$$(a + 2b)^{1/2}$$

where

$$a = [(x_n - x_i)^2 + (y_n - y_i)^2 + (z_n - z_i)^2]$$

$$b = [\Delta x(x_n - x_i) + \Delta y(y_n - y_i) + \Delta z(z_n - z_i)]$$

Expanding this form using the binomial series expansion we obtain

$$\begin{aligned}(a + 2b)^{1/2} &= (a)^{1/2}[1 + 2b/a]^{1/2} \\ &= (a)^{1/2}[1 + b/a + \text{Higher order terms}]\end{aligned}$$

By noting that all higher order terms contain second order and higher terms of Δx, Δy, or Δz, we may ignore them and our equation reduces to

$$\begin{aligned}(a)^{1/2}[1 + b/a] &= (a)^{1/2} + (a)^{1/2}[b/a] \\ &= (a)^{1/2} + b/(a)^{1/2} \\ &= R_{ni} + \Delta R_i - T_n - \Delta T \qquad (4)\end{aligned}$$

Substituting our incremental relationship for R_{ni} into this equation and simplifying

$$(a)^{1/2} + b/(a)^{1/2} = [(a)^{1/2} + T_n] + \Delta R_i - T_n - \Delta T \qquad (5)$$

or

$$b/(a)^{1/2} = \Delta R_i - \Delta T \qquad (6)$$

But

$$R_{ni} = (a)^{1/2} + T_n \Longrightarrow (a)^{1/2} = R_{ni} - T_n$$

Substituting this expression and our expression for b into equation (6) we obtain the linearized equations (i= 1,2 3,4) that relate pseudorange measurements to the desired user navigation information as well as the user's clock bias:

$$[(x_n - x_i)/(R_{ni} - T_n)]\,\Delta x + [(y_n - y_i)/(R_{ni} - T_n)]\,\Delta y$$
$$+ [(z_n - z_i)/(R_{ni} - T_n)]\,\Delta z + \Delta T$$
$$= \Delta R_i \tag{7}$$

The quantities on the right-hand side of equation (7) are known; they are simply the differences between the actual measured pseudoranges and the predicted measurements which are supplied by the user's computer based on knowledge of the satellite position and current estimate of the user's position and clock bias. The quantities to be computed (Δx, Δy, Δz, and ΔT) are the corrections that the user will make to his current estimate of his position and time bias. The coefficients of these quantities on the left-hand side represent the direction cosines of the line of sight vector from the user to the satellite as projected along the x, y, and z coordinate axis system (14:98).

The four linearized equations represented by (7) can be expressed in matrix notation as

$$\begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & 1 \\ \beta_{21} & \beta_{22} & \beta_{23} & 1 \\ \beta_{31} & \beta_{32} & \beta_{33} & 1 \\ \beta_{41} & \beta_{42} & \beta_{43} & 1 \end{bmatrix} \times \begin{bmatrix} \Delta x \\ \Delta y \\ \Delta z \\ \Delta T \end{bmatrix} = \begin{bmatrix} \Delta R_1 \\ \Delta R_2 \\ \Delta R_3 \\ \Delta R_4 \end{bmatrix}$$

where β_{ij} is the direction cosine of the angle between the range to the ith satellite and the jth coordinate (14:98).

To express this equation more compactly we will let

r = the four element pseudorange measurement difference vector

x = user position and time correction vector

B = the 4 x 4 solution matrix

$$B \equiv \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & 1 \\ \beta_{21} & \beta_{22} & \beta_{23} & 1 \\ \beta_{31} & \beta_{32} & \beta_{33} & 1 \\ \beta_{41} & \beta_{42} & \beta_{43} & 1 \end{bmatrix}$$

$$x \equiv [\Delta x \quad \Delta y \quad \Delta z \quad \Delta T]^T$$

$$r \equiv [\Delta R_1 \quad \Delta R_2 \quad \Delta R_3 \quad \Delta R_4]^T$$

Thus our equation becomes simply

$$Bx = r \qquad \text{or} \qquad x = B^{-1} r \tag{8}$$

which compactly expresses the relationship between pseudorange measurements and user position and clock bias.

To understand how the geometry of the satellites at a point in time can result in a system outage, we need only examine the solution matrix. If the ends of the unit vectors from the user to the four satellites selected are in a common plane, the direction cosines of the four unit vectors along a direction perpendicular to this plane are all equal. When this occurs, the determinant of the 4 x 4 solution matrix becomes zero (solution matrix becomes singular) and no solution is

possible from the four equations. Consequently, the navigation equations "blow up" and what is known as a "system outage" occurs due to the poor geometry. The situation where this occurs is very close to where the four satellites are in a common plane in space as shown in Figure 5 below.

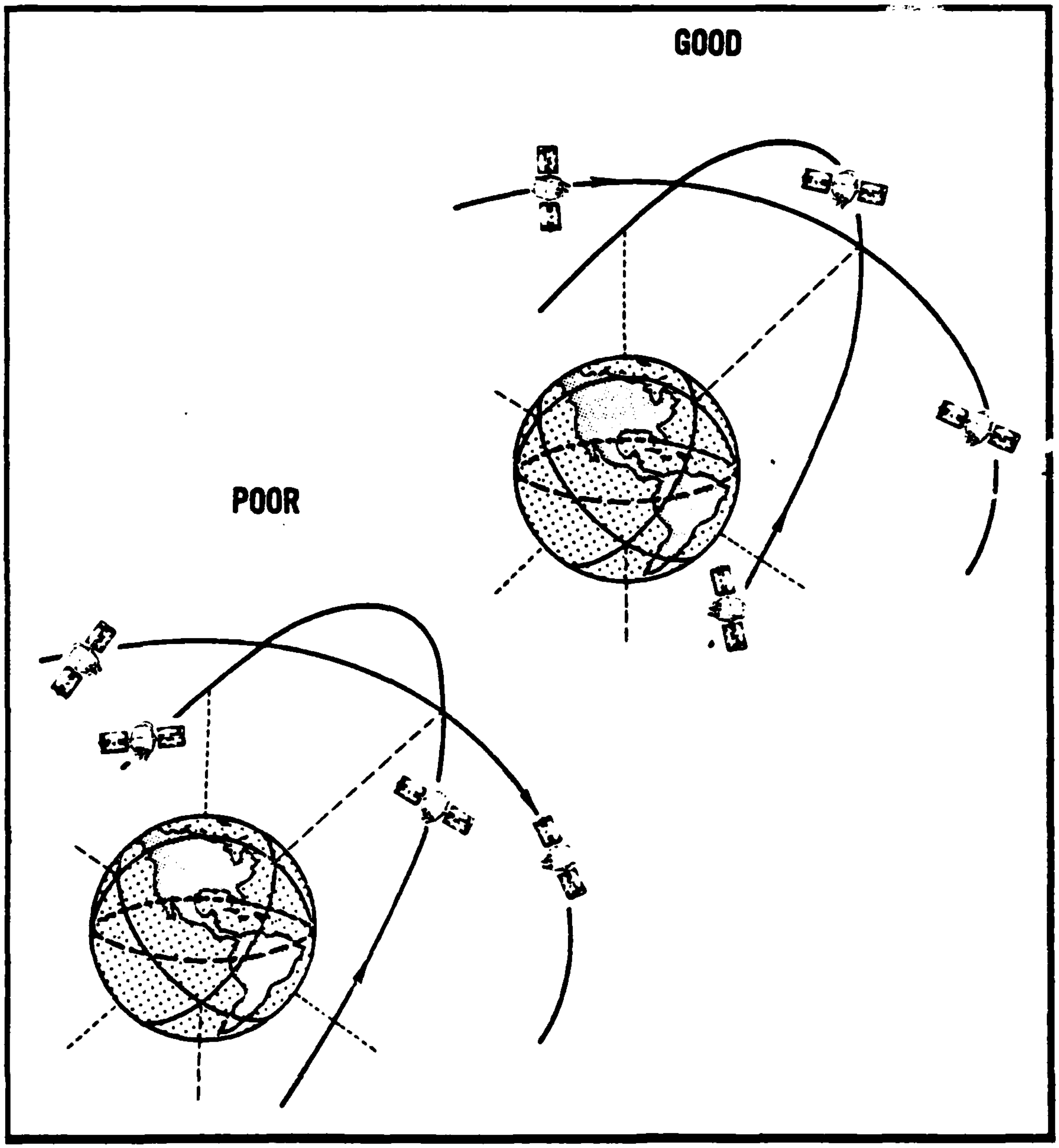

Figure 5. I..ustration of Navstar Satellite Geometry (11:433)

User Position Accuracy

In order to determine the accuracy available from the four satellites selected as a function of their geometry, we must calculate the dilution of precision (DOP) values available from the four satellites selected. Since the overall position accuracy is a product of this value and other system errors, small DOP values are highly desirable in order to yield accuracies on the order of those previously shown in Table I. We have already seen how a poor geometry of the four satellites selected results in the "blowing up" of the navigation equations; the corresponding effect on the DOP values is to cause them to become infinitely large (resulting in a system "outage") which lasts until the geometry of the four satellites improves or an additional satellite becomes available providing a new combination with more favorable geometry.

Since the navigation equation (8) we derived in the last section is a linear relationship, it can also be used to express the relationship between errors in pseudorange measurement and the errors in user position and clock bias. Mathematically, the relationship can be expressed

$$\varepsilon_x = B^{-1} \varepsilon_r$$

where

$\varepsilon_r \equiv$ pseudorange measurement errors

$\varepsilon_x \equiv$ corresponding error in user position and clock bias

If we let

$C_r \equiv$ covariance matrix of errors in pseudorange measurements

and

$C_v \equiv$ covariance matrix of the resulting errors in the three components of user position and clock bias

then the matrix relationship between the two covariance matrices becomes

$$C_v = B^{-1} C_r B^{-T} \tag{9}$$

where B is the same 4 x 4 matrix of coefficients of the unknowns that we derived previously and is a function only of the direction cosines of the LOS unit vectors from the user to the four navsats and the user's clock bias (17:10). Thus, the error relationships are functions only of satellite geometry, which leads to the concept of geometric dilution of precision as a measure of how satellite geometry degrades accuracy (14:99).

In order to provide a method of quantitatively determining whether a given satellite geometry is good or bad, we will assume that the geometric effects on the errors in pseudorange measurements are very small (a reasonable assumption). Thus, a good approximation of the geometric performance can be obtained by letting each individual pseudorange measurement have a one sigma error of unity; thus, the covariance matrix for the errors in pseudorange measurements becomes a 4 x 4 identity matrix (14:99). This means that the ranging errors from each satellite are assumed to be unity, completely random, and that the correlation of ranging errors between satellites is zero. To a good approximation,

$$C_v = (B^T B)^{-1},$$

and assuming sufficient signal strength, this covariance matrix depends only on the *direction* and is in no way dependent on the *distances* between the user and each satellite (17:10). Since the diagonal elements of this covariance matrix are actually the variances of user position and time, various DOP values can be obtained from looking at appropriate elements of this matrix. These values can then be used to compare position accuracies (from a geometry standpoint) of different orbital configurations as well as to measure the overall effect of geometry to errors in the user's position and time bias.

Dilution of Precision Values

If we express the diagonal elements of the covariance matrix of errors in user position and clock bias as V_x, V_y, V_z, and V_T, then the four dimensional *geometrical dilution of precision* (GDOP) is obtained by taking the square root of the trace of the matrix:

$$GDOP = [V_x + V_y + V_z + V_T]^{1/2}$$

This factor includes all four unknowns (three dimensions of position and time) and is the conventional measure of overall geometric performance.

A more frequently used measure of geometric performance is the three dimensional *position dilution of precision* (PDOP) which relates only to the three components of position error. PDOP is also invariant with the coordinate system and is used because the most important consideration in any navigation system is position accuracy; knowing time is a secondary byproduct (14:100). It is defined as the square root of the sum of the squares of the three components of position error, or mathematically:

$$PDOP = [V_x + V_y + V_z]^{1/2}$$

Several other alternative DOP values are also occasionally used in evaluating satellite constellations and relate only some of the variances of user position and time. These include the *horizontal dilution of precision* (HDOP), the *altitude dilution of precision* (VDOP), the *time dilution of precision* (TDOP), and the *larger component of horizontal position error* (MDOP). HDOP, VDOP, TDOP, and MDOP are the DOP factors that apply for the horizontal position error, the altitude error, the error in user clock bias (multiplied by the speed of light), and the larger component of the horizontal position error, respectively. They are defined mathematically as follows (17:10):

$$HDOP = [V_x + V_y]^{1/2}$$

$$VDOP = [V_z]^{1/2}$$

$$TDOP = [V_T]^{1/2}$$

$$MDOP = \text{Max}\,[(V_x)^{1/2}, (V_y)^{1/2}]$$

Satellite Selection

In order to obtain the most accurate user position, it would be highly desirable to utilize those four satellites with the most favorable geometry (lowest DOP values) with respect to the user at any instant of time. This presents no problem, should there be only four visible satellites to choose from, as all four must be used to determine the user's three dimensional position. The majority of the time, however, there will be six or more satellites in view by an earth based user and even more by a low altitude satellite user, and the computational time required to compute PDOP values for all the possible combinations of satellites is excessive.

The results of many computer runs and analytical studies have demonstrated an almost total correlation between PDOP and the volume of a tetrahedron formed by lines connecting the tips of the four unit vectors from the user toward the four navsats (17:11). Usually, the larger the volume of this tetrahedron, the smaller the corresponding PDOP value will be for this same set of satellites. Since the computational time for computing the volume of a tetrahedron for each different combination of satellites is much less than the time required to calculate a PDOP value (which requires a matrix inversion), the computer program used in this work as well as many other similar studies in the past is designed to first compute the volumes of the tetrahedrons associated with each different combination of four satellites, identify the "best four" which yield the largest tetrahedron volumes, and then use that combination of satellites to compute the DOP

values (17:12). Other methods of selecting the optimum four satellites may possibly be more efficient and have been the subject of many analytical studies, but they will not be addressed in this paper. The problem of satellite selection is not only a problem to those conducting global analyses of orbital constellations for evaluation, but it is just as significant a problem to the designers of User Set Equipment, as the equipment must be designed to operate quickly in a dynamic environment and large computer resources are not available.

IV. Baseline Constellation Analysis

Global Distribution Run

Introduction. The reference orbit parameters for the GPS baseline constellation used in this analysis are given in Table II. The computer program used in conducting the analysis was a modified version of a program developed by the Rand Corporation of Santa Monica, California, on the geometric performance of pseudoranging navigation satellite systems (17). This program, which itself is a modification of an earlier program, developed by the Aerospace Corporation for earth-based users, was selected for the evaluation over the computer program currently being used by the Aerospace Corporation, EGAD (Efficient GPS Availability Determination) Program (5:2), for several reasons. First, the Rand Corporation program had been modified to accommodate users in any earth orbit, while the EGAD program did not have any provision for the space-based user. The EGAD program, although a much longer program with many more capabilities, restricted the shape and size of the orbits of the navigation satellites; the program modified by the Rand Corporation allows the user to select any size or shape of the orbits of either the navsats or the user satellite. Finally, the Rand Corporation program includes a feature which allows for the variation of the navsat antenna beamwidth and determines the effect of this variation on navigational accuracy for satellite users; the EGAD Program has no such capability.

A modification was made to the Rand program to allow for the determination of the effect of satellite losses on the baseline or any other alternative constellation. In addition, a few corrections were found necessary in order for the program to give reliable statistics on DOP's when fewer than four satellites were visible. A minor modification of the program output was also made to provide the number of satellites visible to the space-based user when fewer than four satellites were available to the user satellite. A description of the program and its modifications

is provided in Appendix B, and the complete computer program listing is given in Appendix C.

TABLE II

Baseline Constellation Orbital Parameters (13: D2.3.3)

Satellite Number	Orbit Plane	Longitude of the Ascending Node [Deg]	Right Ascension of the Ascending Node [Deg[a]]
1	1	000	030
2	1	060	030
3	1	120	030
4	2	080	090
5	2	140	090
6	2	020	090
7	3	160	150
8	3	040	150
9	3	100	150
10	4	060	210
11	4	120	210
12	4	000	210
13	5	140	270
14	5	020	270
15	5	080	270
16	6	040	330
17	6	100	330
18	6	160	330

[a] Referenced to astronomical coordinates of 1950.0 as of 1 July 1985, 0 hr 0 min GMT and regressing at −0.04009 deg/day.

Selection of Parameters. For all global distribution runs, a uniform distribution of users is approximated by the DOP's of users at a given latitude by the cosine of that latitude. Whenever the constellation selected was a symmetrical arrangement of satellites, only the DOP's

for the northern hemisphere were calculated as this permitted a larger number of sample points to be selected for the analysis. Since the arrangement is symmetrical, an analysis (on a global basis only) of the same number of sample points uniformly distributed in the southern hemisphere would yield identical results. Consequently, the results shown for the analysis of the northern hemisphere are statistically representative of the entire globe.

The proper latitude and longitude step sizes were determined from the analysis of several data runs using alternative parameters. The largest step sizes that would provide statistically representative values were selected to provide a good balance between accuracy and computer computation costs, which are enormous for global distribution runs. The time increments used were selected in a similar manner.

For symmetrical constellations, the time interval selected for each run was four hours, since after this length of time, each satellite within the constellation would have moved to the original position of the satellite adjacent (within the same orbit) to it at the start of the run. (Each satellite is separated from each other within the orbital planes by four hours.) Since this analysis was concerned only with the geometric performance of the baseline constellation for a global basis, rather than for specific user locations, this four hour time period provides statistically good data for any 24 hour period, due to the repetiveness of the satellite motion.

For the non-symmetrical constellations, the time interval analyzed was increased to six hours, or half the 12 hour orbital periods of the GPS satellites. This is the minimum time period that could be chosen to provide statistically representative data (on a global basis) for any 24 hour period. As a result of the longer time interval required for each run, the time increments were doubled in order to remain within computer constraints and yet still provide reasonably accurate data. Since the analysis in these cases focused on the comparative results between constellations analyzed, rather than exact DOP values, this step size was found to be adequate.

TABLE III

Baseline Constellation Orbital Elements

	ORBITAL ELEMENTS					
	ECC	ARGP (Deg)	RASC (Deg)	INC (Deg)	ANOM (Deg)	PER (Hrs)
1	0.00	0.00	30.00	55.00	0.00	12.00
2	0.00	0.00	30.00	55.00	120.00	12.00
3	0.00	0.00	30.00	55.00	240.00	12.00
4	0.00	0.00	90.00	55.00	40.00	12.00
5	0.00	0.00	90.00	55.00	160.00	12.00
6	0.00	0.00	90.00	55.00	280.00	12.00
7	0.00	0.00	150.00	55.00	80.00	12.00
8	0.00	0.00	150.00	55.00	200.00	12.00
9	0.00	0.00	150.00	55.00	320.00	12.00
10	0.00	0.00	210.00	55.00	120.00	12.00
11	0.00	0.00	210.00	55.00	240.00	12.00
12	0.00	0.00	210.00	55.00	360.00	12.00
13	0.00	0.00	270.00	55.00	160.00	12.00
14	0.00	0.00	270.00	55.00	280.00	12.00
15	0.00	0.00	270.00	55.00	40.00	12.00
16	0.00	0.00	330.00	55.00	200.00	12.00
17	0.00	0.00	330.00	55.00	320.00	12.00
18	0.00	0.00	330.00	55.00	80.00	12.00

PARAMETERS USED IN GLOBAL DISTRIBUTION CALCULATIONS:

MASKING ANGLE = 5.00 DEGREES
LATITUDE STEP = 10.00 DEGREES
LONGITUDE STEP = 20.00 DEGREES
TOTAL TIME (MIN) = 240
TIME INCREMENT (MIN) = 5
HEMISPHERE EVALUATED = NORTHERN

Results. If we define an "outage" to be situations where the PDOP for a given location at some time exceeds 6.0 (a 1-sigma ranging error of 7 meters would provide a RMS error of 6.0 x 7m, or 42 meters in this case), as is commonly chosen on analyses of this nature, then we can observe (Table IV) that for the 18-satellite baseline constellation, outages occur only 0.55% of the time over a 24 hour period, or stated in another way, PDOP values of less than 6.0 are available 99.45% of the time.

TABLE IV

Baseline Constellation Global Distribution - DOP Values

DILUTION OF PRECISION PARAMETERS - ACCUMULATIVE GLOBAL DISTRIBUTION
(Percentage of Time That DOP Value Shown is Exceeded)

VALUE	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP
0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1.0	1.0000	1.0000	.8772	.7294	1.0000	1.0000
2.0	.5489	.0397	.0141	.1080	.9832	.9976
3.0	.1183	.0060	.0041	.0098	.2125	.3149
4.0	.0288	.0025	.0025	.0049	.0523	.1080
5.0	.0055	.0025	.0025	.0041	.0114	.0317
6.0	.0049	.0025	.0025	.0041	**.0055**	.0103
7.0	.0041	.0025	.0025	.0025	.0041	.0055

The highlighted number represents the percentage of time that an *outage* occurs due to poor satellite geometry of the baseline constellation. A PDOP value greater than 6.0 is considered to constitute such an outage.

This agrees closely with a similar analysis conducted earlier by the **Aerospace Corporation** on the same six-plane constellation (15: E9.3.2), and verifies the accuracy of the data. If we choose to alternatively define an outage as a PDOP greater than 7.0, as some studies on earlier constellation designs have assumed, then we can see that PDOP's greater than 7.0 occur only 0.41% of the time for the proposed baseline constellation. Although this paper is concerned primarily with the PDOP values, statistics for all six DOP's are listed in Table IV, and a complete breakdown of each DOP by latitude is provided in the appendix.

The maximum and minimum number of satellites available to the user at each latitude and longitude are shown in Table V. (Note that not all latitudes and longitudes are observed.) The probabilities of n or more satellites being visible above a 5 degree elevation angle are shown in Table VI. For the proposed 18-satellite baseline constellation, at least four satellites are always available to the earth-based user, and consequently, *the outages that occur are due solely to the poor geometry of the satellites available to the user.* By examining the computer output located in the appendix on each individual DOP for each latitude, we can also determine the location of these outage areas during any 24 hour period. Typical location of outages and time durations for the six-plane constellation are depicted in Figure 6, 7, 8, and 9. As one can observe from either these pictorial presentations or by the computer output located in the appendix, the primary outage locations for the baseline constellation occur in pairs approximately centered on latitudes of 35N and 65S, with corresponding pairs centered at 35S and 65N, as shown in Figure 7.

TABLE V

Maximum and Minimum Numbers Seen at Each Latitude and Longitude

MAXIMUM

LONGITUDE (DEG)

LAT	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340
90	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
80	8	8	8	7	8	8	8	8	7	8	8	8	7	8	8	8	8	7
70	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
60	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
50	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
40	7	6	7	8	7	6	7	8	8	7	6	7	8	7	6	7	8	8
30	7	6	7	8	7	6	6	8	8	7	6	7	8	7	6	6	8	8
20	7	7	7	7	6	7	7	7	7	7	7	7	7	6	7	7	7	7
10	7	8	8	8	7	8	8	8	8	7	8	8	8	7	8	8	8	8
0	7	8	7	8	8	8	8	7	8	7	8	7	8	8	8	8	7	8

MINIMUM

LONGITUDE (DEG)

LAT	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340
90	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
80	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
70	5	6	5	5	5	5	5	5	5	5	6	5	5	5	5	5	5	5
60	4	5	4	5	4	4	4	4	4	4	5	4	5	4	4	4	4	4
50	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
40	5	4	4	5	5	4	4	5	5	5	4	4	5	5	4	4	5	5
30	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
20	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
10	5	6	6	5	5	6	6	6	5	5	6	6	5	5	6	6	6	5
0	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6

TABLE VI

Probability of Seeing N or More Satellites

	NUMBER OF SATELLITES								
LAT	0	1	2	3	4	5	6	7	8
	PROBABILITY (IN PERCENT) OF SEEING N OR MORE SATELLITES								
90	100.00	100.00	100.00	100.00	100.00	100.00	100.00	30.61	30.61
80	100.00	100.00	100.00	100.00	100.00	100.00	100.00	62.13	3.40
70	100.00	100.00	100.00	100.00	100.00	100.00	97.05	42.40	16.78
60	100.00	100.00	100.00	100.00	100.00	98.41	77.78	44.22	11.34
50	100.00	100.00	100.00	100.00	100.00	100.00	73.02	7.03	0.00
40	100.00	100.00	100.00	100.00	100.00	94.33	57.6	8.84	1.36
30	100.00	100.00	100.00	100.00	100.00	100.00	52.61	14.51	2.72
20	100.00	100.00	100.00	100.00	100.00	100.00	74.38	21.32	0.00
10	100.00	100.00	100.00	100.00	100.00	100.00	89.57	47.85	4.99
0	100.00	100.00	100.00	100.00	100.00	100.00	100.00	57.37	1.36

ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT N OR MORE SATELLITES WILL BE VISIBLE

	NUMBER OF SATELLITES								
PROB	0	1	2	3	4	5	6	7	8
	100.00	100.00	100.00	100.00	100.00	99.17	77.9	31.5	3.49

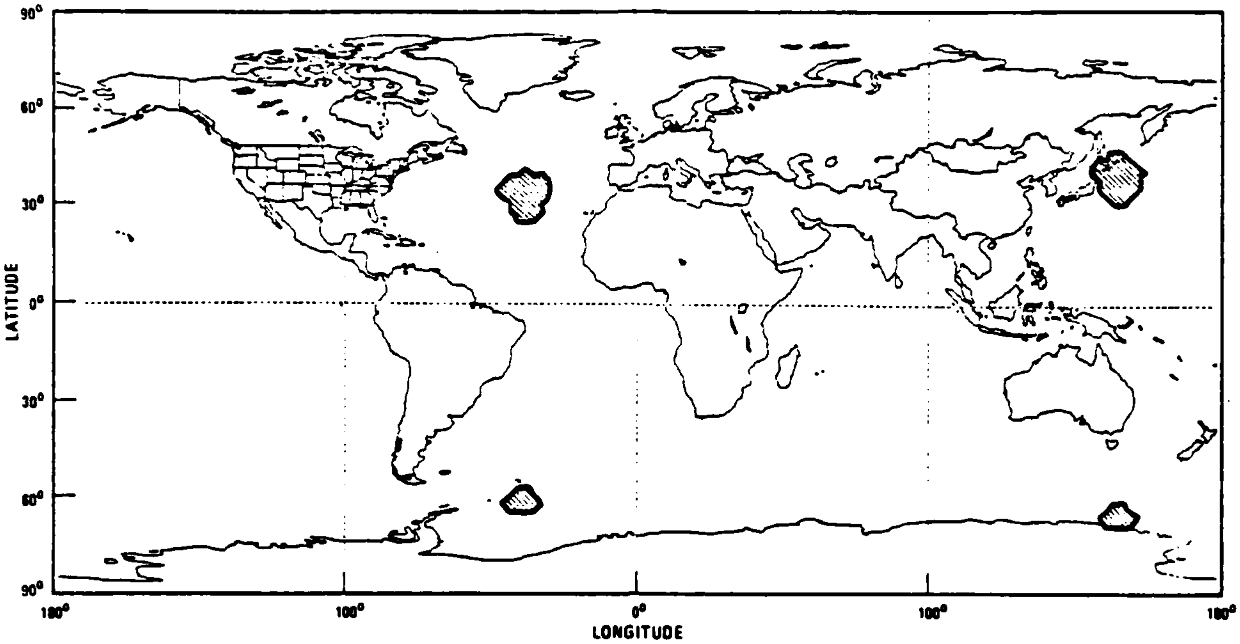

Figure 6. Typical Outages for the Baseline Constellation (15: E9.3.4)

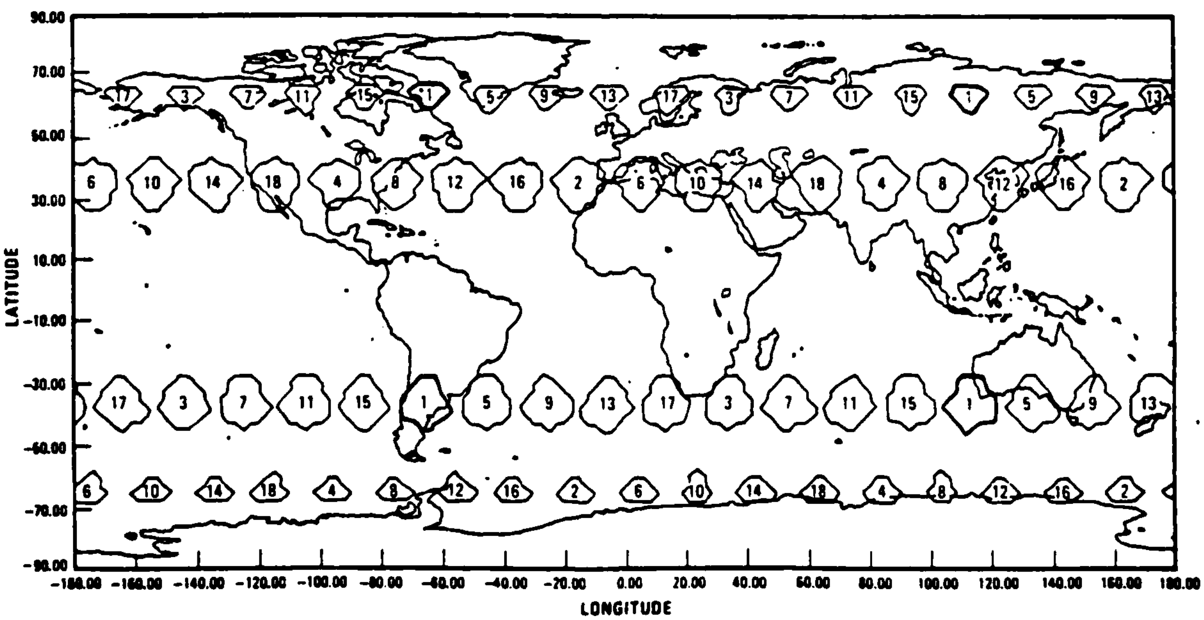

Figure 7. Composite Outages for the Baseline Constellation (15: E9.3.4)

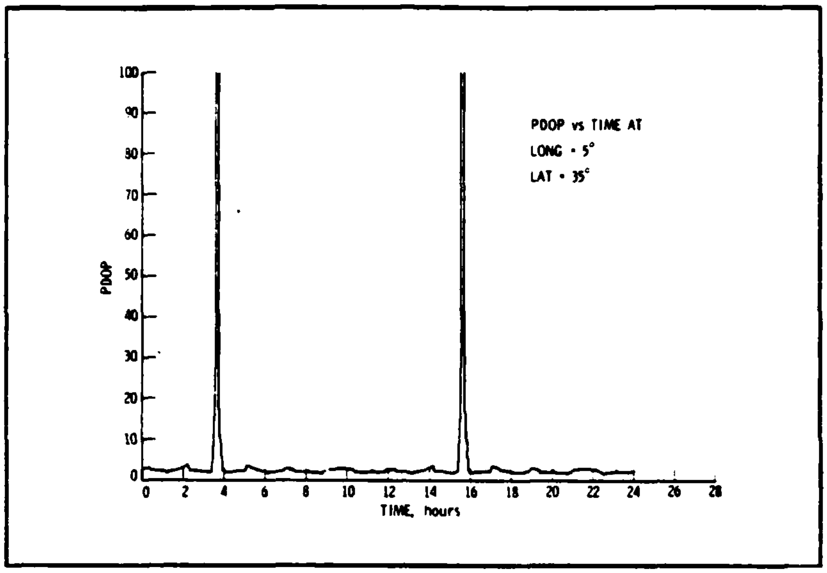

Figure 8. Sample Outage Time Profile for the Baseline Constellation (15: E.9.3.5)

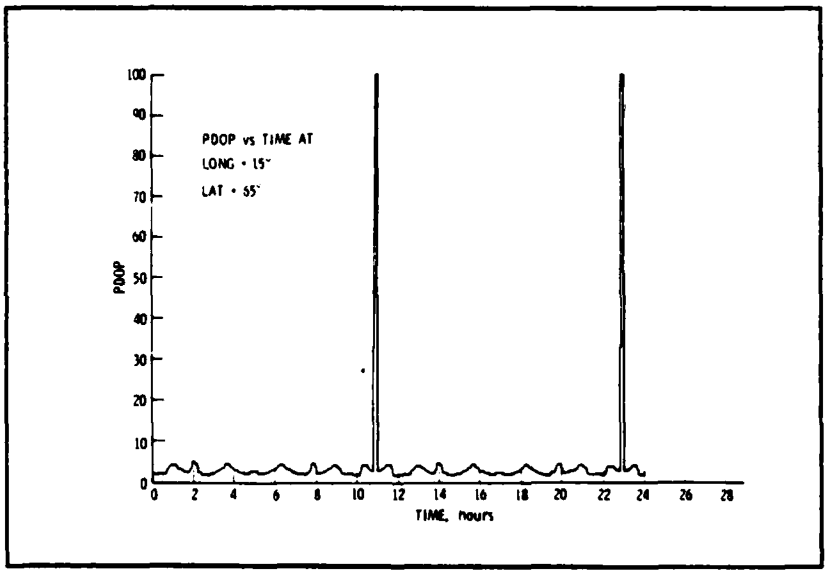

Figure 9. Sample Outage Time Profile for the Baseline Constellation (15: E9.3.5)

System Degradation Due to Satellite Losses

Introduction. The effect of satellite losses from the 18-satellite baseline constellation was also analyzed on a global basis, as this was one of several factors considered in selecting the optimum configuration of the 18 satellites. For this part of the analysis, it was assumed that no active, in-orbit spares were available. The effect upon geometric performance from losses of one to three satellites was evaluated was evaluated for several representative cases, with an emphasis on determining the *best* and *worse cases* possible, instead of on the expected performance due to *random* satellite losses, as most earlier studies have dealt with. "Best case" information might be particularly useful to those involved in the initial buildup of the constellation to its full operational 18-satellite configuration as a means of determining both the order and placement of each successive satellite deployment. Likewise, "worst case" scenarios might prove to be useful to those military planners seeking defenses against anti-satellite weapons that potential enemies might design and deploy. Since computer restraints did not permit all possible combinations of satellite losses to be analyzed (for the three satellite case there are 816 possible combinations), the satellite losses analyzed were carefully selected in order to determine the *most probable* best and worst cases. In addition, many of the combinations, due to the symmetric arrangement of the satellites and their repetitive nature, provided identical degradation of performance (from a global standpoint) and could be excluded. For example, if only one satellite is lost (or destroyed), *any satellite selected* will degrade the geometric performance in the same way as any other *one* satellite lost. (Only the location of the outages will differ, which could be of interest to military planners). Similarly, a loss of a pair of satellites (1) and (4) degrade system performance the same amount (on a global basis) as a loss of satellites (2) and (5), (3) and (6), (5) and (8), and many other symmetrically equivalent pairs. (One need only realize that in four hours satellites (1) and (4) move to the same inertial positions as (2) and (5) were originally

located in order to understand this).

Results. By examining the tabular data on some representative runs in Table VII, one can easily see that *which* satellites are deleted from the constellation greatly affect the amount of degradation to system performance.

TABLE VII

System Performance Degradation Due to Satellite Losses

Satellites Deleted	% PDOP > 6.0	% PDOP >7.0
None	.0055	.0041
6	.0230	.0198
1	.0232	.0201
1,5*	**.0478**	**.0407**
1,12	.0488	.0458
1,2	.0507	.0434
1,7	.0515	.0450
1,8	.0720	.0634
1,6	.0749	.0695
1,4	.0779	.0697
1,11	.0782	.0716
1,9	.0787	.0709
1,10**	**.0800**	**.0725**
4,5,6*	**.0780**	**.0679**
1,7,13	.1017	.0900
1,7,8	.1042	.0920
1,4,5	.1057	.0928
1,2,4	.1349	.1245
1,4,7	.1380	.1258
1,9,15	.1387	.1289
1,10,11	.1435	.1325
1,8,15**	**.1584**	**.1454**

* Best Case
** Worst Case

As is evident from this table, the percentage of time a system outage occurs in the two satellite loss "worst case" scenario is actually greater than the percentage of time that an outage occurs in the three satellite loss "best case" (8.00% versus 7.80%). The range of values (expressed as percentages of PDOP > 6) is rather widely spread from the best to worst cases, varying from 4.78% to 8.00% in the two satellite case and from 7.80% to 15.84% in the three satellite case. From examining this data, it appears that a loss of closely grouped satellites, such as three adjacent satellites within the same plane, provide the "best case" situation, while, as might be expected, losses of satellites widely separated generally result in the "worst case" scenario. For the three satellite (loss) cases analyzed, this is easily deduced from observing that the best case occurs when all satellite losses occur in the same plane, while the worst case occurs when the satellites deleted are separated to the maximum. From this information, it appears that should satellite losses be sustained, *a significant improvement in performance might be obtained in the interim (until replacement spares could be launched) by rephasing the remaining satellites to provide as wide as possible average separation between all satellites per period.* Should the three satellite spares already be on-orbit as presently planned, it suggests that these spares would be optimally positioned in every other orbital plane, and repositioned as necessary within each orbit when losses are sustained, to obtain the widest possible distribution of remaining satellites. Presently, the planned location for placement of these three additional in-orbit spares is depicted in Figure 10, and should provide this opportunity.

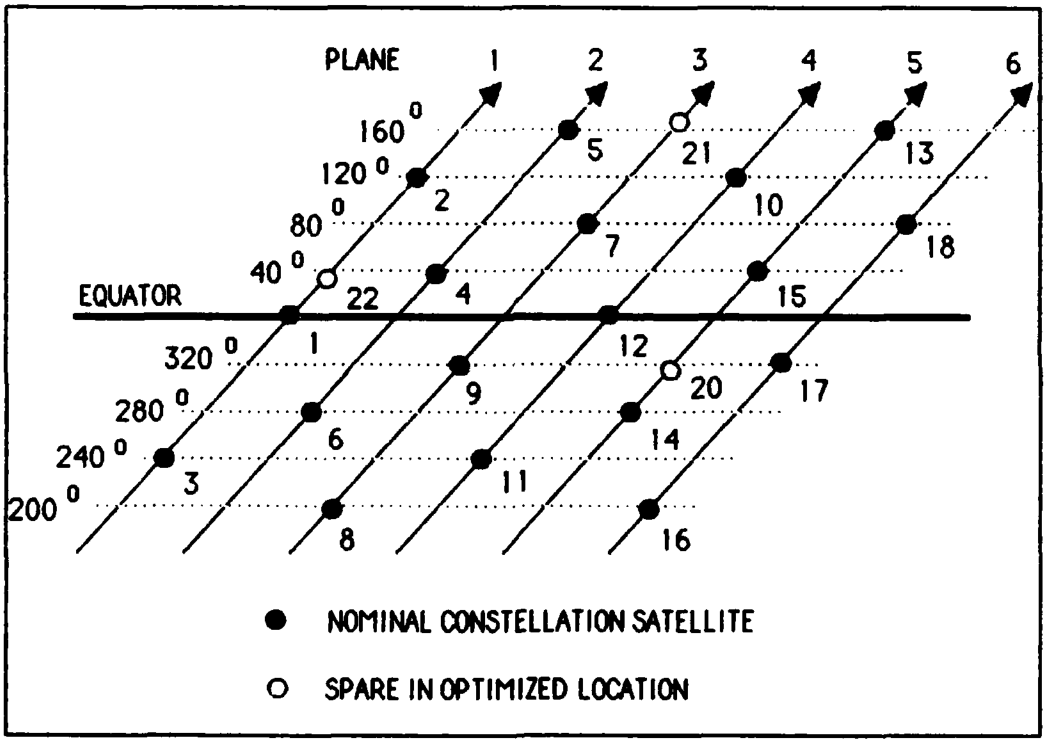

Figure 10. Baseline Constellation With Three Spares (15:E9.3.7)

Satellite User

Introduction. Although the Global Positioning System was designed for use by the earth or near-earth based user, its potential application for autonomous navigation of satellites and space navigation is highly desirable. Until recently, few studies have been conducted in this area, yet based on the those studies that have been made regarding this potential application, the results appear promising. At least one analysis has shown that a three-dimensional accuracy on the order of 100 meters can be obtained for autonomous navigation of geosynchronous satellites (13:D2.3.1), and even better accuracies can be achieved for space-based users at lower altitudes.

In analyzing the geometric performance of the baseline constellation for the satellite user, the antenna pattern design of the GPS satellites severely limits the times and numbers of GPS satellites that can be observed by the satellite user, particularly at the higher altitudes. In this somewhat limited analysis of the geometric performance of the GPS satellites for the satellite user, its potential for navigation of the spaceborne user was examined by analyzing DOP's obtainable for a user in low-earth orbit, high-earth orbit, and intermediate elliptical orbits, as well as for a high altitude ballistic missile trajectory. The effect of changing the antenna beam angle of the GPS satellites upon the geometric performance of the system for these spaceborne users was also analyzed to determine if significant improvement could be obtained, particularly for the high altitude user.

Antenna Design. The GPS satellites utilize a helical array that provides a conical shaped beam to cover the earth uniformly from their altitude of 10,900 nautical miles. This antenna array also provides a skirt within its main lobe that extends beyond the edge of the earth to a limited degree, and it is this part of the antenna pattern that the geosynchronous satellite user may utilize for navigation. For the L1 frequency, the main beam antenna gain at the edge of the

earth is approximately 14 dB, dropping gradually to about 3 dB at about 21.4 degrees from the satellite to earth center line, or an 11 dB variability in antenna gain (Figure 11) over this skirt region (13:D2.3.2).

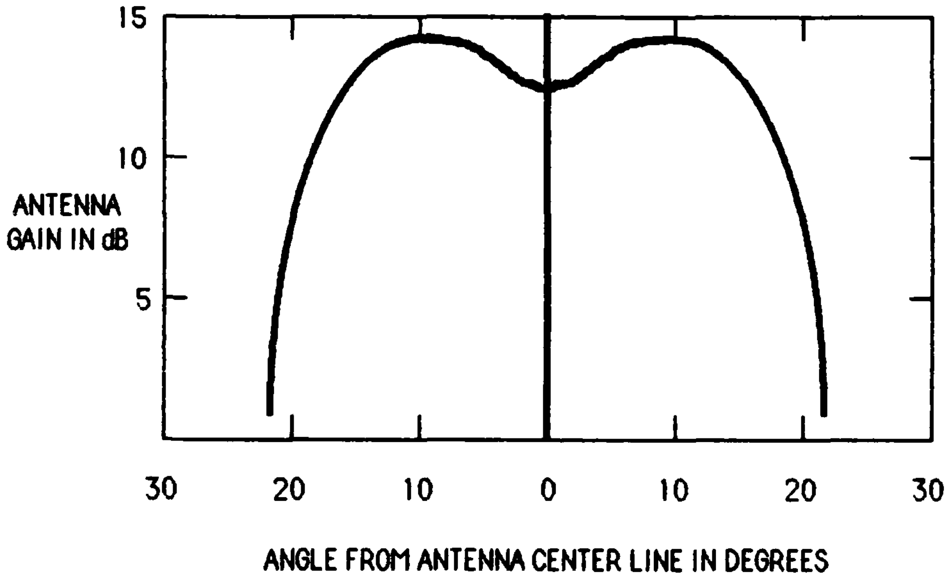

Figure 11. Main Beam Antenna Gain at L1 Frequency (13:D2.3.3)

As the user spacecraft approaches the GPS satellites, the NAVSTAR satellites keep their antennas directed toward the center of the earth, thus forcing the user to obtain signals coming from the NAVSTAR sidelobes and/or backlobe (11:432), as shown in Figure 12. Although at high altitudes, users will have only the edge of the antenna pattern available, this could be adequate for updating ephemerides if an accurate on-board clock is available (20:21.2.1).

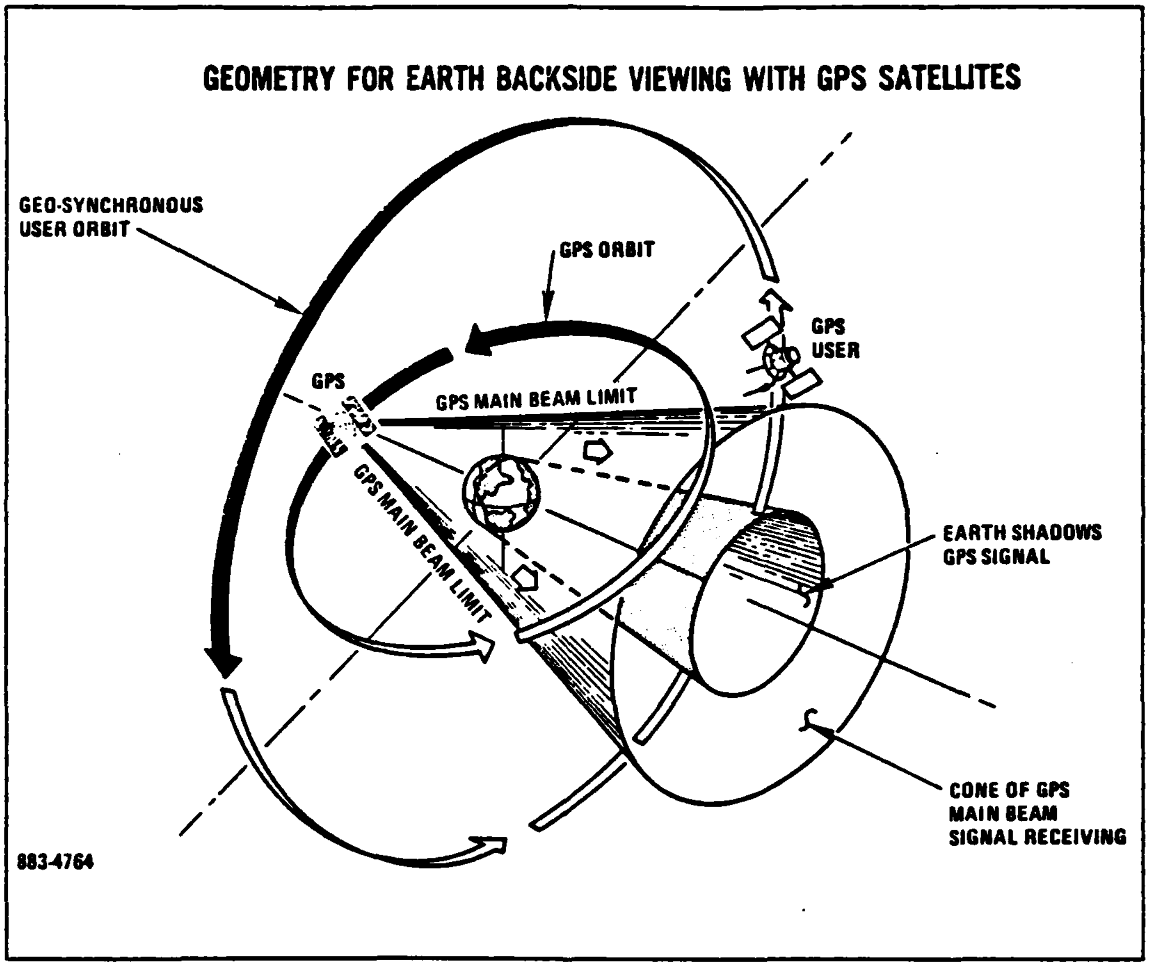

Figure 12. Main GPS Beam Geometry (11:432)

Low Altitude Earth Orbits. A 150 nautical mile altitude circular parking orbit (Case 1) was selected as a typical low altitude earth orbit for the evaluation. The orbit chosen had an inclination of 28 degrees and a 90 minute period. DOP values were computed at increments of 5 minutes over a total time of 12 hours. For the designed antenna half-angle beamwidth of 21.4 degrees, the PDOP values obtained were extremely good, as were expected, and ranged from a best value of 1.61 to a worst value of 2.155. Since the PDOP values using the designed antenna beamwidth were significantly better than even for the typical earth-based users, evaluation at other antenna beamwidths was not necessary.

Intermediate Altitude Earth Orbits. For this evaluation, a highly elliptical Hohman transfer orbit (Case 2) from a low altitude parking orbit to geosynchronous orbit was chosen as representative of an intermediate altitude earth orbit. The eccentricity of the selected orbit was 0.73, and it had a 0 degree inclination. The orbital period was 10.56 hours. DOP values were computed at 5 minute intervals over a 12 hour period. When analyzed with the designed antenna half-angle beamwidth of 21.4 degrees, four or more satellites were visible only 17.9% of the time , three or more satellites for 24.1% of the time, and two or more satellites for 51% of the time. No satellites were visible to the user in this orbit 29% of the time.

The same satellite user orbit was also analyzed using an antenna half-angle beamwidth of 45 degrees, with significantly better results. With this modification to antenna design, four or more satellites were available to the user at all times, with PDOP values ranging from 1.539 to 38.663. PDOP values less than 6.0 were achieved 35.2% of the time. The results are summarized in Table VIII.

Table VIII

Baseline Constellation Evaluation - Satellite User

User Satellite	Antenna BWIDTH	% of Time n or More Satellites Visible 1	2	3	4	PDOP Range
Case 1	21.4	100.0	100.0	100.0	100.0	1.61 - 2.155
Case 2	21.4	71.0	51.0	24.1	17.9	1.544 -
	45.0	100.0	100.0	100.0	100.0	1.539 - 38.663
Case 3	21.4	100.0	100.0	100.0	100.0	1.537 - 1.818
Case 4	21.4	62.8	29.5	12.4	7.8	1.505 -
	45.0	100.0	100.0	100.0	100.0	1.523 - 127.57
	90.0	100.0	100.0	100.0	100.0	1.504 - 9.361
Case 5	21.4	55.2	22.1	1.4	0.0	
	45.0	100.0	100.0	100.0	100.0	14.55 - 93.023
	90.0	100.0	100.0	100.0	100.0	6.199 - 7.928
	180.0	100.0	100.0	100.0	100.0	5.560 - 7.505

Low Altitude ICBM Trajectory. A typical ICBM profile (Case 3) was chosen for this portion of the evaluation. The elliptical trajectory selected had an eccentricity of .55 and a period of about 1.2 hours. Time of flight from launch to impact was approximately 40 minutes, and the maximum altitude attained was slightly less than 1400 nautical miles. DOP values were computed at one minute intervals for the duration of the flight. As in the low altitude earth orbit (Case 1), exceptionally good PDOP values were achieved with the designed antenna beamwidth throughout the flight, ranging from 1.537 to 1.818, as shown in Table VIII. Four or more

satellites were always visible, and the PDOP values improved with increasing altitude all the way to approximately 1400 nautical miles.

High Altitude Ballistic Missile Trajectory. A highly elliptical ballistic trajectory (Case 4) with an eccentricity of .82 and a period of 11.05 hours was analyzed. Maximum altitude attained during flight was approximately 21,200 nautical miles. DOPs were computed at five minute intervals for the duration of the flight. For the designed antenna half-angle beamwidth, four or more satellites were visible only 7.8% of the time, three or more satellites only 12.4 % of the time, and two or more visible only 29.5% of the time. There were no satellites visible 37.2% of the time.

When the same case was analyzed using an antenna half-angle beamwidth of 45 degrees, four or more satellites were always visible, with PDOP values ranging from 1.523 to 127.569. PDOP values less than 6.0 were achieved 20.9% of the time. As in the previous case, PDOP values actually improved from launch up to approximately 1400 to 1800 nautical miles in altitude. When the antenna half-angle beamwidth was increased to 90 degrees, PDOP values improved significantly, ranging from 1.504 to 9.361, and PDOP values less than 6.0 were achieved 50.3% of the time, and values less than 7.0 were achieved over 72% of the time.

High Altitude Earth Orbits. A circular, geosynchronous earth orbit (Case 5) was selected for evaluation and analyzed for several different antenna configurations. DOPs were again computed at five minute intervals over a 12 hour period. With the designed antenna beamwidth there were never four satellites visible. Three or more satellites were visible only 1.4% of the time, two or more 22.1% of the time, and one or more visible only 55.2% of the time. The geosynchronous user can observe no satellites 44.8% of the time with the designed antenna beamwidth.

When the antenna half-angle beamwidth was increased to 45 degrees (and higher), four or

more satellites were always visible (Table VIII), and PDOP values improved significantly with increasing beamwidth angle. At an antenna half-angle beamwidth of 90 degrees, PDOP values less than 7.0 were achieved 62.1% of the time. When increased even further to the maximum 180 degrees, PDOP values less than 7.0 were achieved 87.6% of the time, ranging from values of 5.56 to 7.505.

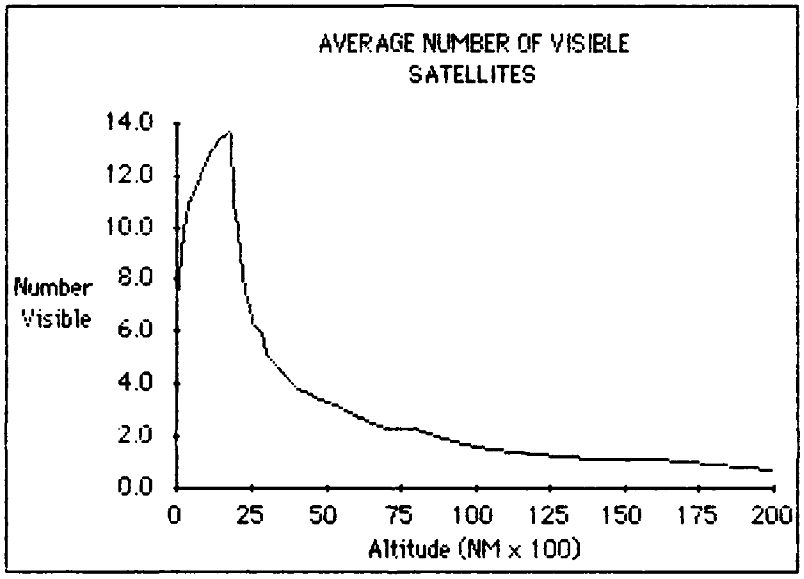

Figure 13. Average Satellite Visibility as a Function of Altitude

Summary. For the low altitude satellite user, the baseline GPS constellation will provide accuracies far exceeding those obtained on the earth's surface, as for these altitudes (less than about 1800 nautical miles), PDOP values generally improve with increasing altitude. More satellites are generally visible to choose from, resulting in better geometry, as shown in Figure 13. As the satellite user approaches higher altitudes, however, the constraints due to antenna beamwidth cause a significant degradation of performance and result in frequent outages caused by the insufficient number of satellites available to the user. Even in these situations, however,

navigation can be made possible by means of sequential measurements from the GPS satellites as they become visible to the user, a precise on-board clock, and the knowledge of the known orbital dynamics of the satellite. Furthermore, the improvements in accuracy that can be obtained by increasing the antenna half-angle beamwidth can certainly not be overlooked, as such a modification of antenna design could significantly increase the position accuracy available to the high altitude satellite user and should be considered if GPS is to be designed for space navigation as well as for tactical earth navigation.

Another limitation on the use of GPS for space navigation is geometrical in nature. Not only is it necessary to have four satellites in view for three-dimensional positioning, but the positions of these satellites should be widely distributed about the user in all directions to minimize PDOP values. Even with unlimited antenna gain and 360 degree coverage (180 degree antenna half-angle beamwidth) there is a limit to the position accuracy that can be achieved at higher and higher altitudes, as the relative separation of the GPS satellites with respect to the user continues to diminish with distance. Consequently, the altitude dilution of precision (VDOP) becomes larger and larger, and primarily as a result of this growing component, the three dimensional position dilution of precision (PDOP) becomes exceedingly high. For this reason, GPS will probably never be practical for space navigation between planets in the solar system and beyond, but certainly is feasible for satellite navigation or for the navigation of other spacecraft designed for near- earth orbital operations.

V. Baseline Modification Analysis

The Modified Constellation

Introduction. The six-plane, 18-satellite constellation analyzed in Chapter IV was recognized as having better overall capability than a variety of other candidate 18-satellite constellations evaluated and is now considered to be the baseline GPS constellation. One of the primary reasons that this constellation was chosen over an earlier three-plane, nonuniform constellation baseline proposal was that a significant improvement of satellite coverage was obtained with the six-plane configuration (15:E9.3.8). The 99.5% coverage of the six-plane constellation was found to be significantly better than the 98.4% coverage of the three-plane constellation, since the difference between these two is a measure of the difference from total or 100% coverage and translates into size and duration of degraded performance areas (15:E9.3.2).

In all satellite constellations considered in the selection process, circular orbits of equal period were chosen as an essential feature; it had been assumed that elliptical orbits were advantageous for coverage of limited areas, but that the more uniform patterns provided by circular orbits were preferable for whole-Earth coverage (22:4). Walker's expectation that "continuous whole-Earth coverage would be provided most effectively by a system in which the distribution of satellites over the Earth's surface was maintained as uniform as possible, subject to the practical limitations imposed on a system necessarily involving multiple intersecting orbits," has been the underlying basis for this assumption. Although it would appear to be a reasonable assumption, it does not take into account the fact that system outages are caused not only by an insufficient number of satellites visible to the user, but also by the poor geometry (with respect to the user) that may exist for those satellites in view.

Since, for the baseline constellation, there are always four or more satellites in view to the

earth-based user, all outages that occur must be due to the poor relative geometry of the visible satellites; this was a direct observation from the global distribution analysis of Chapter IV. If a modification to this baseline constellation could be made that would result in more favorable geometry during these outage periods, without causing an increase in outages at other times, it seems logical to expect that coverage could be improved even further. Since a change in the shape of the orbit, or eccentricity, would result in a change in geometry, it seems reasonable to expect that elliptical orbits might provide such an opportunity.

Assumptions. It was assumed that the only modification to be made to the baseline constellation was to the eccentricity (shape) of the orbits. Thus, all modified constellations considered consisted of 18 satellites deployed in six elliptical planes, three satellites per plane, each with an orbital period of 12 hours. Each orbital plane had an inclination of 55^0, and was separated from the next by 60 degrees in longitude. The three satellites in each orbital plane were uniformly distributed in time; this means that each was separated from the other within a particular orbit by four hours, or exactly one-third of the period. Relative phasing of the satellites from one orbital plane to the next remained at 40^0; this means that when an ascending satellite in one plane is crossing the equator, an ascending satellite in the adjacent plane to the east is 40^0 above the equatorial plane in its own orbital plane. Since elliptical orbits were used, the relative phasing of the satellites was approximated by positioning the ascending satellite in the adjacent plane to the east ahead of the equator by 40^0 of eccentric anomaly. For ease in constellation buildup, as well as in the evaluation and comparison with the baseline constellation, it was assumed that the eccentricity chosen for one orbit would be used for all six orbits.

Choosing the Modified Constellation. With the assumptions stated above, there still remained the difficult task of choosing the optimum orbital eccentricity and perigee locations, which, it was hoped, would provide the improved coverage desired. From a practical standpoint,

a small eccentricity would be desirable, as satellite stationkeeping and antenna pointing would be easier if the orbits were kept as nearly circular as possible. In addition, if the orbits were made too elliptical, outages would begin to occur due to periods when fewer than four satellites would be visible to a user, rather than due solely to poor geometry; this would negate any advantage attained by the improving geometry resulting from the elliptically-shaped orbits. Since this is exactly what occurred at eccentricities much greater than 0.1, an eccentricity of .05 was initially chosen as a starting point for the computer analysis.

Since a satellite in an elliptical orbit travels at slowest speed near apogee and at fastest speed near perigee, it spends the majority of its time near the apogee end of its orbit. By positioning the apogees of each orbit over a specific area of the earth where increased coverage is desired, a tremendous improvement in performance was noted; unfortunately, however, this was at the expense of a significant degradation of performance in other areas of the world. Thus, when the apogees of the orbits were positioned over the middle northern latitudes, the outages were virtually eliminated in the northern hemisphere while becoming more frequent and of longer duration in the southern hemisphere (Table IX). As a result of the preliminary computer runs, it was determined that a near optimum location, on a global basis, for the perigees of the modified elliptical orbits was in the plane of the equator, as outages occurred less frequently in these particular cases than any other location analyzed.

After analyzing several data runs for constellations with eccentricities ranging from .01 to .1 and with all perigees located in the equatorial plane, an eccentricity of .07 was selected as the optimum value of eccentricity that would minimize the percentage of time outages would occur (Table IX). It is significant to note that *all* eccentricities between .01 and .1 provided superior performance than that of the baseline constellation in terms of reducing system outages.

TABLE IX

Global Distribution Preliminary Data Runs

Eccentricity	Arg of Perigee [Deg]	Hemisphere	% PDOP > 6.0	%PDOP >7.0
.05	239.7	Northern	.0012	.0010
.05	239.7	Southern	.0107	.0087
.02	239.7	Northern	.0070	.0048
.02	239.7	Southern	.0084	.0068
.05	224.5	Northern	.0009	.0003
.05	224.5	Southern	.0114	.0106
.02	224.5	Northern	.0028	.0023
.02	224.5	Southern	.0082	.0069
.02	198.4	Northern	.0032	.0025
.02	198.4	Southern	.0071	.0062
.01	0.0	Northern	.0048	.0039
.02	0.0	Northern	.0041	.0037
.03	0.0	Northern	.0041	.0034
.04	0.0	Northern	.0038	.0029
.05	0.0	Northern	.0040	.0026
.07	0.0	Northern	.0029	.0017
.085	0.0	Northern	.0034	.0015
.10	0.0	Northern	.0037	.0016

Global Distribution Run

Introduction. Since the modified constellation selected was, like the baseline constellation, a symmetrical arrangement of satellites, only the DOP's for the northern hemisphere were calculated. The DOP's for the southern hemisphere are identical for a global analysis. The latitude, longitude, and time steps were chosen to be the same as used for the baseline constellation global distribution run, which allowed for the direct comparison of the

results. The time interval selected for the run, as in the case of the baseline constellation, was four hours, as after this length of time the pattern of outages was repetitive due to the symmetric arrangement of satellites.

TABLE X

Modified Constellation Orbital Elements

	ORBITAL ELEMENTS					
	ECC	ARGP (Deg)	RASC (Deg)	INC (Deg)	ANOM (Deg)	PER (Hrs)
1	0.07	0.00	30.00	55.00	0.00	12.00
2	0.07	0.00	30.00	55.00	126.60	12.00
3	0.07	0.00	30.00	55.00	233.40	12.00
4	0.07	0.00	90.00	55.00	42.80	12.00
5	0.07	0.00	90.00	55.00	160.30	12.00
6	0.07	0.00	90.00	55.00	269.50	12.00
7	0.07	0.00	150.00	55.00	83.80	12.00
8	0.07	0.00	150.00	55.00	193.90	12.00
9	0.07	0.00	150.00	55.00	310.00	12.00
10	0.07	0.00	210.00	55.00	123.30	12.00
11	0.07	0.00	210.00	55.00	230.00	12.00
12	0.07	0.00	210.00	55.00	355.70	12.00
13	0.07	0.00	270.00	55.00	161.40	12.00
14	0.07	0.00	270.00	55.00	270.60	12.00
15	0.07	0.00	270.00	55.00	44.10	12.00
16	0.07	0.00	330.00	55.00	198.60	12.00
17	0.07	0.00	330.00	55.00	315.90	12.00
18	0.07	0.00	330.00	55.00	89.40	12.00

PARAMETERS USED IN GLOBAL DISTRIBUTION CALCULATIONS:

MASKING ANGLE = 5.00 DEGREES
LATITUDE STEP = 10.00 DEGREES
LONGITUDE STEP = 20.00 DEGREES
TOTAL TIME (MIN) = 240
TIME INCREMENT (MIN) = 5
HEMISPHERE EVALUATED = NORTHERN

Results. The results of the global analysis computer run for the modified constellation are shown in Table XI. It is significant to note that, for the modified constellation, outages occur only 0.29% of the time, or stated in another way, PDOP values of less than 6.0 are available 99.71% of the time; this represents a 47% reduction of outages over the baseline constellation (Figure 14), which has outages occuring 0.55% of the time. If PDOP values greater than 7.0 are used as a means of comparison, outages (PDOP values greater than 7.0) are reduced by over 58%.

TABLE XI

Modified Constellation Global Distribution - DOP Values

DILUTION OF PRECISION PARAMETERS - ACCUMULATIVE GLOBAL DISTRIBUTION
(Percentage of Time That DOP Value Shown is Exceeded)

VALUE	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP
0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1.0	1.0000	1.0000	.8260	.7297	1.0000	1.0000
2.0	.5681	.0439	.0185	.1009	.9849	.9991
3.0	.1202	.0030	.0018	.0143	.2257	.3430
4.0	.0334	.0009	.0006	.0018	.0650	.1111
5.0	.0063	.0004	.0004	.0013	.0138	.0431
6.0	.0022	.0004	.0003	.0011	**.0029**	.0114
7.0	.0012	.0003	.0003	.0009	.0017	.0028

The highlighted number represents the percentage of time that an *outage* occurs due to poor satellite geometry of the baseline constellation. A PDOP value greater than 6.0 is considered to constitute such an outage.

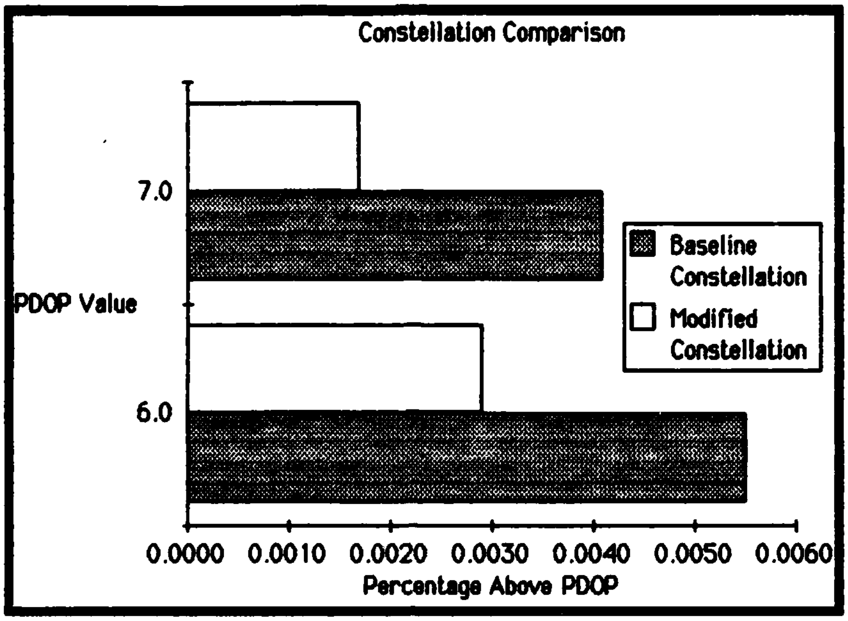

Figure 14. Comparison of System Outages

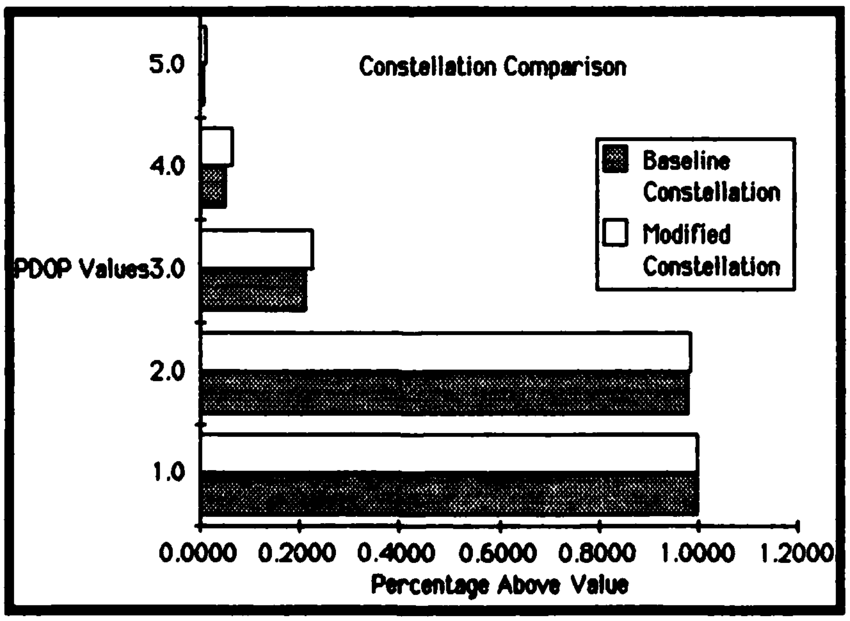

Figure 15. Comparison of PDOP Values Less Than 6.0

This reduction in system outages that occurs with the modified system is not without *some* cost. The cost of this increased coverage, however, is limited to a very slight reduction in the percentage of times that the best PDOP values are obtainable, as depicted in Figure 15. An examination of the data in Table XII and Table XIII provides the reason for this slight degradation of the best PDOP values obtainable. Although the minimum and maximum number of satellites visible to the global user remained basically the same as for the baseline constellation, the distribution of their occurrences did not. Since the analysis showed that there were always four or more satellites visible to the earth-based user for both the baseline constellation and the modified system, the outages that occurred were attributed to the poor relative geometry of the four satellites selected. In almost every case where this occurred for the baseline constellation, there were only the minimum number of four satellites from which to choose from. A close examination of Table VI confirms this, as the data clearly shows that five or more satellites were in view 100% of the time at all northern latitudes sampled except at 60°N and 40°N, which were also the latitudes at which the outages occurred.

The modified constellation, however, provides a higher probability of seeing five or more satellites at these same latitudes, which means that in addition to the change in relative geometry of satellites provided by the elliptical orbits, additional satellites from which to choose are made available over the specific regions of the earth where the outages had occurred. Consequently, the addition of a fifth satellite over these areas provided an opportunity for a better relative geometry of the four satellites selected and eliminated nearly half the outages that had previously occurred in these areas. Since this fifth satellite was provided at the expense of a reduction of the number of satellites available in other areas which previously had a higher number of satellites from which to select, the best PDOP values obtainable in these other areas were slightly degraded. Thus, although on a global basis the modified constellation provided a slightly lower probability in

percent (98.92% to 99.17%) that five or more satellites would be seen, it effectively redistributed the "wealth" by targeting those areas of the world with weakest coverage.

TABLE XII

Maximum and Minimum Numbers Seen at Each Latitude and Longitude-Modified Constellation

MAXIMUM

LONGITUDE (DEG)

LAT	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340
90	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
80	7	8	8	8	7	8	8	8	7	8	8	7	7	8	8	8	8	7
70	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
60	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
50	7	7	7	7	7	7	7	7	6	7	7	7	6	7	7	7	7	7
40	7	6	6	8	7	7	6	8	8	7	7	6	8	7	6	6	8	8
30	7	7	6	7	7	7	6	8	8	7	7	6	7	7	7	6	7	7
20	6	8	7	7	6	8	8	7	7	7	7	7	7	6	8	8	7	7
10	7	8	7	8	8	8	8	7	7	7	8	7	7	7	8	8	7	7
0	7	8	7	7	8	7	7	7	8	7	8	7	8	7	8	8	7	7

MINIMUM

LONGITUDE (DEG)

LAT	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340
90	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
80	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
70	5	6	6	5	5	5	6	5	5	5	6	5	5	5	5	5	5	5
60	4	5	5	5	4	4	5	5	4	4	6	5	5	4	6	5	5	5
50	5	5	5	5	5	5	5	5	5	5	4	5	5	5	4	4	4	5
40	5	4	4	5	5	4	4	4	5	5	4	4	5	5	4	4	5	5
30	5	5	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
20	5	5	4	4	5	5	5	4	5	5	5	4	4	5	5	5	4	5
10	5	6	6	6	5	6	6	6	5	5	6	6	5	5	6	6	5	5
0	6	5	5	5	6	6	5	5	5	6	5	5	5	6	6	5	5	5

TABLE XIII

Probability of Seeing N or More Satellites-Modified Constellation

NUMBER OF SATELLITES

LAT	0	1	2	3	4	5	6	7	8
	PROBABILITY (IN PERCENT) OF SEEING N OR MORE SATELLITES								
90	100.00	100.00	100.00	100.00	100.00	100.00	100.00	40.82	24.49
80	100.00	100.00	100.00	100.00	100.00	100.00	100.00	61.22	3.51
70	100.00	100.00	100.00	100.00	100.00	100.00	96.03	42.40	14.97
60	100.00	100.00	100.00	100.00	100.00	99.21	82.54	41.27	10.20
50	100.00	100.00	100.00	100.00	100.00	99.32	70.07	12.47	0.00
40	100.00	100.00	100.00	100.00	100.00	95.12	62.02	7.26	1.59
30	100.00	100.00	100.00	100.00	100.00	99.89	63.49	14.97	.23
20	100.00	100.00	100.00	100.00	100.00	97.85	74.49	20.86	1.36
10	100.00	100.00	100.00	100.00	100.00	100.00	94.44	45.24	2.04
0	100.00	100.00	100.00	100.00	100.00	100.00	96.71	52.61	1.81

ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT N OR MORE SATELLITES WILL BE VISIBLE

NUMBER OF SATELLITES

PROB	0	1	2	3	4	5	6	7	8
	100.00	100.00	100.00	100.00	100.00	98.92	80.25	30.42	2.79

System Degradation Due to Satellite Losses

Introduction. The effect of satellite losses from the modified baseline constellation was analyzed for comparison with the results obtained from the analysis of the baseline constellation discussed in Chapter IV. For this limited analysis, the effect upon geometric performance from losses of one to three satellites was evaluated for the same cases that provided both the best and worst performance for the baseline constellation. Whether or not these cases are the equivalent best and worst cases for the modified constellation as well remains to be determined, but since this part of the analysis was conducted solely for the purpose of comparing the two constellations, these cases should provide adequate representation of the broad range of effects.

For each computer run, a ten minute time increment was selected and the constellation was evaluated over a six hour period. The latitude and longitude step sizes were 20° and both hemispheres were evaluated. These parameters were identical to those used in the analysis of satellite losses from the baseline constellation, which adds validity to the comparison.

Results. The percentage of time that system outages occurred due to satellite losses from the modified constellation are listed in Table XIV. The percentages in brackets represent the corresponding values obtained for the same losses analyzed for the baseline constellation (Table VII). In practically every case, the modified baseline constellation provided superior performance over the baseline constellation. As seen in the baseline analysis, the particular satellites removed from the constellation made a large difference in the amount of degradation occurring; outages occurred in the three satellite loss case from 8.11% to 15.3% of the time and in the two satellite case from 4.55% to 7.47% of the time, representing the best and worst case scenarios.

TABLE XIV

System Performance Degradation Due to Satellite Losses- Modified Constellation

Satellites Deleted	% PDOP > 6.0	% PDOP > 7.0
1	.0228 [.0232]	.0161 [.0201]
1,5*	.0455 [.0478]	.0329 [.0407]
1,10**	.0774 [.0800]	.0661 [.0725]
4,5,6*	.0811 [.0780]	.0574 [.0679]
1,8,15**	.1530 [.1584]	.1349 [.1454]

* Best Case
** Worst Case

Satellite User

Introduction. In analyzing the geometric performance of the modified baseline constellation for the satellite user, three cases were considered: an intermediate altitude earth orbit, a high altitude earth orbit, and a high altitude ballistic missile trajectory. The low altitude earth orbit and ICBM trajectory were not considered for this analysis as it was assumed that the modified constellation would provide outstanding geometric performance for these two users, as had been the case with the baseline constellation. In any event, the three cases selected were representative of the wide range of potential satellite users and were considered adequate for the purposes of this limited comparison.

The parameters selected for the computer analyses of each case were identical with those used in the analyses of these cases for the baseline constellation, and the cases analyzed were identical to those described in Chapter IV. It was assumed that the GPS antennas remained pointed

at the center of the earth throughout the orbit of the satellites, and that a sufficiently strong signal was available to the user satellite at all distances.

Intermediate Altitude Earth Orbits. The orbital parameters of the highly elliptical satellite user orbit considered were described in Chapter IV (Case 2). It was analyzed for an antenna half-angle beamwidth of 21.4 degrees and 45 degrees. With the designed antenna half-angle beamwidth of 21.4 degrees, four or more satellites were visible 18.6% of the time compared with 17.9% for the baseline constellation. Three or more satellites were visible 26.2% of the time versus 24.1% for the baseline, and two or more satellites were visible 53.8% of the time compared with 51% for the baseline. No satellites were visible to the satellite user 27.6% of the time.

When the same user orbit was analyzed using an antenna half-angle beamwidth of 45 degrees, as in the case of the baseline analysis, significantly better results were obtained. Four or more satellites were available to the user at all times during its orbit, with PDOP values ranging from 1.53 to 123. PDOP values less than 6.0 were achieved 32.4% of the time compared with 35.2% for the baseline constellation. The results are summarized in Table XV.

High Altitude Ballistic Missile Trajectory. The same highly elliptical missile trajectory (Case 4) described in Chapter IV was used in this analysis as had been used for the baseline analysis. Half-angle beamwidths of 21.4 and 45 degrees were selected for the comparison evaluation. With the designed antenna half-angle beamwidth, four or more satellites were visible to the user 7.8% of the time, identical to the results of the baseline analysis. Three or more satellites were available 14.0% of the time compared to the baseline 12.4%, two or more were visible 30.2% of the time versus 29.5% for the baseline, and one or more satellites were available 61.2% of the time compared to 62.8% for the baseline constellation. There were no satellites visible 38.8% of the time. When the half-angle beamwidth was increased to 45 degrees,

four or more satellites were always visible, as was found to be the case for the baseline constellation. PDOP values less than 6.0 were achieved in this case 22.5% of the time, which was a slight improvement over the 20.9% achieved by the baseline constellation.

Table XV

Modified Constellation Evaluation - Satellite User

User Satellite	Antenna BWIDTH	% of Time n or More Satellites Visible 1	2	3	4	PDOP Range
Case 2	21.4	72.4	53.8	26.2	18.6	1.536 -
	45.0	100.0	100.0	100.0	100.0	1.539 - 123
Case 4	21.4	61.2	30.2	14.0	7.8	1.506 -
	45.0	100.0	100.0	100.0	100.0	1.598 -345
Case 5	21.4	53.8	25.5	2.7	0.0	
	45.0	100.0	100.0	100.0	100.0	14.4 - 166.2
	90.0	100.0	100.0	100.0	100.0	5.7 - 8.8

High Altitude Earth Orbits. A circular geosynchronous orbit was selected (Case 5) for evaluation at antenna half-angle beamwidths of 21.4, 45, and 90 degrees. With the designed antenna beamwidth, there were never four satellites visible. Three or more satellites were visible 2.7% of the time for the modified constellation compared with 1.4% of the time fur the baseline. Two or more satellites were visible 25.5% of the time and one or more visible only 53.8% of the time, compared with 22.1% and 55.2% respectively for the baseline.

When the antenna half-angle beamwidth was increased to 45 degrees and higher, four or more satellites were always available to the user. At a half-angle beamwidth of 90 degrees, PDOP values less than 7.0 were achieved 75.8% of the time compared with 62.1% of the time for the baseline constellation.

Summary. The geometric performance of the modified constellation for the satellite user is probably slightly favorable to that of the baseline constellation. For all three cases analyzed, the modified constellation generally provides more satellites available to the user when less than four satellites are available. When more than four satellites are visible to the user, PDOP values less than 6.0 or 7.0 are achieved a higher percentage of time than for the unmodified baseline constellation, resulting in fewer outages. Although only a limited number of representative orbits were considered in the analysis, one can only conclude from the results that the modified constellation performs at least on an equal basis with that of the baseline constellation for the typical satellite user, and probably better. Although GPS performance for the space-based user was not considered as a factor in the selection of the baseline constellation, it certainly merits consideration. Both the baseline constellation and the modified constellation show great potential for use in near-earth space navigation.

VI. Conclusions/Recommendations

The Baseline Satellite Constellation

The 18-satellite configuration now considered the GPS baseline constellation will provide nearly continuous coverage on a worldwide basis to its earth-based users, providing them with positioning capability of high accuracy on the order of tens of meters. Those system outages that do occur with the proposed system will be due solely to the poor geometry of the selected satellites, and these outages will only occur (on an average) approximately one-half percent of the time. The duration of these outages will be brief (5-30 minutes) and the locations predictable.

Satellite losses sustained by the 18-satellite constellation will significantly degrade the coverage available, and the amount of degradation caused by such losses will be largely dependent on the relative positions of those satellites lost. Should replacement spares be unavailable, rephasing the remaining satellites could substantially improve the coverage until the constellation is restored to its original number. The planned placement of three active, in-orbit spares should greatly increase the system's reliability and provide some flexibility in rephasing satellites to compensate for unplanned losses.

For the satellite or space-based user, the feasibility of using GPS for positioning in the conventional way is primarily a function of both the user's altitude and the antenna beamwidth of the GPS satellites. With the currently designed antenna half-angle beamwidth of 21.4 degrees, the low- altitude satellite user will usually have positioning accuracy capability superior to that of the typical global user due to the increased number of satellites from which to select and the resulting better geometry. Due to the limiting constraints of the antenna beamwidth, however, the space-based user's positioning accuracy will rapidly deteriorate with increasing altitude, as fewer and fewer satellites remain available for selection. Outages become more and more frequent

until altitudes are reached where conventional positioning using four satellites simultaneously becomes impossible. Modifying the antenna beamwidth design of the GPS satellites appears very promising for expanding the usefulness of GPS to the high altitude satellite user, but even without such a modification, greatly improved positioning capability for these users can be obtained by taking sequential measurements from GPS satellites as they become available. Equipping the receiver with a precise clock and incorporating these sequential measurements with the memory inherent in the known orbital dynamics of the satellite will make navigation possible for these users as well.

The Baseline Modification

In an attempt to improve the geometric performance of the baseline constellation by reducing the number and duration of system outages, a modification was made to the baseline constellation which changed the shape of the circular GPS satellite orbits to slightly elliptical ones, each with an eccentricity of .07. The perigee of each satellite orbit was positioned in the plane of the equator; all other orbital parameters remained unchanged. This modification reduced the percentage of system outages occurring on a global basis by nearly 50%, which was a significant improvement in coverage over the baseline constellation. The "cost" for this improvement was a slight reduction in the best accuracies attainable for some areas of the world.

Although elliptical orbits are certainly advantageous for coverage of limited areas of the world, it has generally been assumed that circular orbits are preferable for whole-earth coverage. This assumption, however, does not appear to be valid at least in this particular case, as the outages that occurred with the baseline constellation were due solely to the poor geometry of the available satellites, and not to the lack of sufficient satellites for measurements. Changing the eccentricity of the satellite orbits resulted in a more favorable satellite geometry relative to the

users on a global average; consequently, fewer outages occurred.

The modified constellation also compared favorably to the baseline constellation with respect to the space-based user, providing positional accuracy generally better than that provided to the user by the unmodified constellation. Since only a limited number of user orbital trajectories were examined, it can only be concluded that the modified constellation provides the space-based user with positioning accuracy comparable to that of the baseline, and *perhaps* better.

The effect of satellite losses from the modified constellation were also examined for the cases which provided both the best and worst navigational performance for the baseline constellation. In almost every case, the modified constellation provided better overall coverage than the baseline constellation.

Recommendations

Although the location and duration of system outages is considered a significant factor in selecting the optimum 18-satellite GPS constellation, other factors may make the proposed modification to the baseline constellation impractical to implement. It has been assumed that the necessary satellite station-keeping is available to maintain the orbital pattern for the expected lifetime of the satellite; precession of the line of apsides (perigee movement) due to earth oblateness, for example, is approximately .022 degrees per day, and would require periodic corrections. Further analysis is recommended to determine the feasibility of this modification to the proposed baseline constellation. Since the primary intent of this analysis was to determine whether changing the eccentricity of the GPS satellite orbits *could* improve geometric performance and reduce the percentage of system outages, and *not* to find the optimal constellation, other elliptical variations of the baseline should also be analyzed for comparison.

The feasibility of modifying GPS antenna design to better accommodate the space-based user

should also be closely examined. Although GPS was not originally designed for use in space navigation, the potential applications into this area appear very promising. Increasing the antenna beamwidth, if practical, would greatly improve the availability of the GPS satellites to users operating in space, and would make available to the user extremely accurate estimates of position.

Appendix A

Glossary of Technical Terms

Antenna Half-angle Beamwidth - the angle between the antenna centerline and the edge of the main lobe skirt of the GPS antenna pattern

Apogee - the point in a satellite's orbit farthest from the central attracting body (earth)

Argument of Perigee - the angle, in the plane of the satellite's orbit, between the ascending node and the periapsis point (perigee), measured in the direction of satellite motion

Ascending Node - the vector pointing from the center of the earth to the satellite as it passes through the fundamental (or equatorial) plane in a northerly direction

Clock Bias - the error, or fixed bias, in the user's imprecise clock relative to GPS system time provided by the GPS satellites which contributes an error in range measurement

Dilution of Precision (DOP) - a parameter used for measuring system position accuracy of the GPS satellites as a function of the variability of satellite geometry

Direction Cosines - the numbers, representing the cosines of three angles, which completely define the direction of a given vector relative to a given coordinate system

Eccentric Anomaly - the angle between the semi-major axis of an ellipse and a point on a circle circumscribed about the ellipse represented by the interesection of that circle with a line, perpendicular to the semi-major axis, through the point of interest on the ellipse

Eccentricity - a constant defining the shape of an elliptical or other conic orbit

Fundamental Plane - the plane of the equator

GDOP - the geometric dilution of precision, a parameter which reflects the dilution of precision of position accuracy in three dimensions plus time

Geosynchronous Orbit - a circular orbit with a period of 24 hours, situated in the plane of the equator, such that the satellite always remains over the same point of the earth

Hohman Transfer - an elliptical transfer orbit between two circular orbits requiring minimum fuel for the maneuver

HDOP - the horizontal dilution of precision, a parameter which reflects the dilution of precision of position accuracy in the two horizontal directions

Inclination - the angle which describes the orientation of the orbital plane with the plane of the equator

Ionospheric Delay - the time delay of RF signals passing through the ionosphere due to a reduction of speed and bending of the ray from refraction, inversely proportional to the square of the frequency

Julian Time - the time from which the Julian Calendar dates (46 B.C.)

Longitude of Ascending Node - the angle, in the plane of the equator, between the vector pointing to the vernal equinox and the ascending node, measured counterclockwise when viewed from the north side of the fundamental plane

Masking Angle - the minimum elevation angle, due to terrain obstructions and the earth's atmosphere, that a GPS satellite can have relative to the user and still be usable

HDOP - a parameter which reflects the dilution of precision of position accuracy in the larger component of the horizontal position error

Orbital Elements - the six, independent quantities which are sufficient to completely describe the size, shape, and orientation of an orbit and the position of the satellite along the orbit at a particular time

Outage - a situation occurring for a user at a specific location and time period when positioning capability is unavailable due to either unfavorable satellite geometry or an insufficient number of visible GPS satellites (less than four)

PDOP - the position dilution of precision parameter which reflects the dilution of positioning accuracy in three dimensions

Perigee - the point in a satellite's orbit closest to the earth

Period - the time required for a satellite to traverse its entire orbit one time, dependent only on the size of the semi-major axis

Pseudorange - the sum of the actual range displacement from the user to GPS satellite plus the offset due to the user time error (clock bias)

Relative Phasing - the number of degrees that an ascending satellite in one orbital plane is above the equatorial plane relative to an ascending satellite which is crossing the equatorial plane in an adjacent orbital plane to the west

Satellite Constellation - a particular arrangement or configuration of a specific number of satellites

Satellite Geometry - the geometrical relationship of the four selected GPS satellites relative to the user and each other

Satellite Visibility - a measurement of the number of satellites above a minimum elevation angle (masking angle) visible to a user at a specific time and location

Semi-major Axis - a constant defining the size of a conic orbit

Satellite User - a GPS user situated in space (space-based user)

Sidereal Time - the time based on a sidereal day, which is defined as the time required for the earth to rotate once on its axis relative to the stars (approximately $23^h56^m04^s$ of solar time)

TDOP - the dilution of precision in time which is an estimate of the range equivalent of the user clock bias

True Anomaly - the angle, in the plane of the satellite's orbit, between periapsis and the position of the satellite at a particular time, or epoch

Universal Time - the local mean solar time on the Greenwich meridian, also called Greenwich Mean Time or Zulu time

VDOP - the parameter reflecting the dilution of precision in the vertical dimension (altitude error)

Appendix B
The Computer Program

Introduction

The computer program used for the analysis of all satellite constellations evaluated in this study is a modification of a Fortran program, developed by the Rand Corporation, on the geometric performance of pseudoranging satellite systems (17). Since a complete, detailed description of the original program and its operation can be found in Reference 17, the information contained in this appendix will be limited to an explanation of the variables and subroutines used in the program and the modifications made. In addition to providing the complete program listing in Appendix C, a sample of the output for the two types of cases (global distribution and satellite user calculations) analyzed in this study is provided in Appendix D.

There are three types of calculations performed by the program: in Case I, the user is on a satellite; in Case II, the user is positioned at a specific latitude and longitude on the earth's surface; and, in Case III, a group of users are located at a set of latitudes and longitudes forming a net over the whole surface or an entire hemisphere of the earth (17:15). Since only Case I and Case III were used in this evaluation, no sample output is provided for Case II; that portion of the program was not modified and will not be addressed in this discussion.

Program Modifications

The original program was written in Fortran IV and implemented on an IBM 370/158 computer. This version of the program has been converted to Fortran V for compatibility with a Fortran V compiler. The size dimension of matrix KXX in the main program and in subroutines TAAT and TALL was reduced to accomodate a maximum of 24 navsats, rather than the 36 navsats

provided for in the original program; this was done to cut down on the memory core storage used in the program's operation. A local library matrix inversion routine (LINV2F), was substituted for the matrix inversion routine used in subroutine COVNAV of the original program, and for greater ease in entering data, formatting was changed to allow free field data input.

Although the original program contained statements that would allow the program to continue operation when less than four satellites were available to the earth-based user, it did not consider these occurrences in the calculations of DOP values and thus provided erroneous data for the global distribution calculations when this occurred. The program was modified to incorporate these situations into the probability calculations of DOP values and thus provide accurate data. For the satellite user, it was discovered that the original program's output was not affected by a change in antenna beamwidth; this problem was corrected in the current version. A modification was also made to the satellite user portion of the program to provide as output the number of navsats available to the user when less than four satellites were visible; the original program did not provide this information as output.

Since average DOP values were not calculated by the program for the global distribution runs (the primary interest was in determining when the DOP values would exceed certain limits and cause system outages to occur), additional statements were added to the program setting default DOP values equal to 1000 when the covariance matrix became singular due to poor geometry. This allowed the program to continue operation when such situations were encountered, while the original program would have terminated. Since , in reality, the DOP values approach infinity as an outage occurs, and DOP values much less than this are considered as constituting a system outage (PDOP values less than 6, for example) , the exact values are unimportant at these points as long as they are set substantially higher than those values constituting such an outage. The EGAD program currently in use by the Aerospace Corporation employs the same technique.

One additional subroutine (SATDEL) was added to the program to facilitate the analysis of the effect of satellite losses on a given constellation. Subroutine SATDEL allows for the program user to selectively delete from one to ten satellites from the original constellation for use in comparing the effect upon geometric performance caused by a particular combination of satellites. The number of satellites to be deleted and the particular identification numbers of these satellites are entered as part of the data input at the beginning of the program. This subroutine was necessary to identify which combination of satellites provided the best and worst case navigational accuracy.

Explanation of Variables in Main Program

The variables used in the main program and an explanation of their use is provided in Table XVI and Table XVII. Table XVI lists and explains the variables used for that portion of the program involving the space-based or satellite user, while Table XVII explains those variables used for the global distribution calculations involving the user on the ground.

TABLE XVI

Explanation of Variables in Main Program- Satellite User (17:19-20)

FORTRAN	EQUATIONS	EXPLANATION
RF(IV) RMX(N,IV) R(IV)	$\bar{R}$	Vector from the center of the earth to a navsat (where N is the "identification number" of the navsat and "IV" is the index of the components of the vector)
UPV(IV) RMX(IP,IV)	$\bar{P}$	Vector from the center of the earth to a user satellite (where "IP" is the identification number" of the user satellite and "IV" is as above)
UTS	$\bar{U}$	Vector from a user satellite to a navsat
AR	R	Length of vector $\bar{R}$
AP	P	Length of vector $\bar{P}$
A		$\text{Cos}^{-1}(r/R)$, where r = radius of earth
B		$\text{Cos}^{-1}(r/P)$
PHI	ϕ	$\text{Cos}^{-1}(r/R) + \cos^{-1}(r/P)$
THETN	θ_n	$\text{Cos}^{-1}(\bar{R} \bullet \bar{P}/RP)$
AU	U	Length of vector $\bar{U}$
BETAN	β_n	$\text{Cos}^{-1}(-\bar{U} \bullet \bar{P}/UP)$
AIWID AIN	α	Navsat antenna beamwidth half-angle (input) relative to a vector from the navsat to the center of the earth

TABLE XVI (Continued)

FORTRAN	EQUATIONS	EXPLANATION
BWIDTH		$\pi - (\theta_n - \beta_n)$
USUV(IINT(N),IV) U(IV)	$\bar{e}_i$, i=1,2,3,4	Unit vectors from a user toward 4 navsats (where IINT(N) contains the "identification number" of the satellites which have not been eliminated and "IV" as before)
THETT	θ_T	If $P>R$ $\theta_T = \text{Cos}^{-1}(R/P)$ If $P\leq R$ and β (of the navsat closest to zenith)$>\pi/2$; $\theta_T = 109.5^o - \sin^{-1}(P \sin 19.5^o/R)$ If $P\leq R$ and β (of the navsat closest to zenith)$\leq\pi/2$; $\theta_T = 70.5^o - \sin^{-1}(P \sin 19.5^o/R)$
DELONE	δ_1	If $\text{Sin}^2 \theta_T > C$, $\delta_1 = \text{Sin}^{-1}(C/\text{Sin}\,\theta_1)$ If $\text{Sin}^2 \theta_T \leq C$, $\delta_1 = \theta_T$
DELTWO	δ_2	If $\text{Sin}^2 \theta_T > C$, $\delta_2 = \delta_1$ If $\text{Sin}^2 \theta_T \leq C$, $\delta_2 = \text{Cos}^{-1}(1-2C) - \theta_T$
NUL		Number of navsats
ISCMP		Navsat selection technique parameter (ISCMP=0 for zenith; ISCMP=1 for all satellites taken four at a time)
P(N,K)		Array containing the orbital elements for the satellites (where N is the identification number of the navsat and k=1 to 5 is the index on the first five orbital elements)
PER(N)		Orbital period of navsat or user satellite

TABLE XVI (Continued)

FORTRAN	EQUATIONS	EXPLANATION
CK	C	Numerical value representing the fraction of the area of a sphere with radius equal to the orbital radius of navsats; used in calculating width of band where best satellites will be sought (must be set equal to one when navsats are in elliptical orbits)

TABLE XVII

Explanation of Variables in Main Program- User on Ground (17:21-22)

FORTRAN	EXPLANATION
LATDEG	Latitude step size (5 or 10 degrees)
ELEVAT	Masking angle of users
LATIC,LONIC	Latitude and longitude increments to be used
INC,ITF	Time increment, in minutes, at which calculations are desired and the total number of increments, plus one, desired
R,RMX	Vector from the center of the earth to a satellite
UPV	Vector from the center of the earth to a user
STN	Vector from a navsat to a user
SE	Elevation (masking) angle of a satellite
UTS	Vector from a user to a navsat (-STN)
USUV	Unit vector (of UTS)
NSTO	Total number of navsats in view
NSPL(L)	Total number of navsats in view at each latitude
CL(L)	Total number of latitudes when there are four or more navsats in view
Z	Vector in the polar direction (origin at earth center)
YE	Vector in the eastward direction (origin at the user)
XN	Vector in the northward direction (origin at the user)

TABLE XVII (Continued)

FORTRAN	EXPLANATION
G(NSGD(N),I)	Direction Cosines (where NSGD(N) contains the "identification numbers" of the four selected navsats and I = 1 to 4)
SIGT(N)	An array containing the DOP parameters
CDOP(L,K,IDOP)	Storage for DOPs at each time step; L= latitude index, K= longitude index, IDOP = DOPs index
PIB(IX)	Elevation distribution: the probability that the satellites in view will have specified elevation angles; IX= elevation angle index
CAGX(LA,LC)	Latitude elevation distribution: the probability that any navsat in view will have an elevation angle greater than or equal to those specified; LA=latitude index, LC= elevation range index
GLEB(IC)	Accumulative elevation distribution: the probability that the elevation angle to a navsat is greater than or equal to those listed; IC= elevation range index
QSR(IQSR)	Range into which the printed variable falls; IQSR = 1,36 in steps of .2
SKEGX(LK,IQSR,JDOP)	DOP parameters for overall global performance; LK= latitude index, IQSR (see above), JDOP= DOPs index
MAX(IL,IK)	Maximum number of navsats seen at the intersections of latitudes and longitudes; IL=latitude index, IK= longitude index
MIN(IL,IK)	Minimum number of navsats seen at the intersections of latitudes and longitudes; IL=latitude index, IK= longitude index

TABLE XVII (Continued)

FORTRAN	EXPLANATION
OBLAT(IL,N)	Probability (in percent) of seeing exactly N navsats; IL = latitude index, N=number of navsats
ACLAT(IL,N)	Probability (in percent) of seeing N or more navsats; IL = latitude index, N=number of navsats
OBDIS(N)	On a global basis, the probability (in percent) that exactly N navsats will be seen
ACTOT(N)	On a global basis, the probability (in percent) that N or more navsats will be seen
NDEL	Number of satellites to be deleted from the constellation
JDEL(I)	An array containing the "identification numbers" of deleted satellites

Explanation of Subroutines

Table XVIII lists the individual subroutines utilized in the program and provides a brief explanation of the purpose of each. A more detailed explanation of each subroutine can be found in Reference 17.

TABLE XVIII

Computer Program Subroutines (17:23-27)

SUBROUTINE NAME	DESCRIPTION
ORBINI(N)	Initializes the orbital elements for the navsats and user satellite from the input data
ORBIT(I,T,PER,R,VEL,AC)	Iterates for the eccentric anomaly and computes the true anomaly for each time step
TRMATX(TR,I)	Calculates the 3 x 3 coordinate transformation matrix, TR
MATMUL(T,V,O)	Performs coordinate transformation of a vector by matrix multiplication
POINT(ALO,ALA,TIM,VEC)	Calculates the vector from the center of the earth to the user at a specific latitude and longitude
TAAT(MAX,MXX,MATRIX)	Sets up the sequence of navsats which are to be examined, using either the one above or below the user as one of the four in each calculation of the tetrahedron volume
VOLUME(UVEC,IDSAT,VOL)	Calculates the volume of the tetrahedron formed by the set of four satellites used
COVNAV(G,ID,NAT,SIG)	Computes the six dilution of precision values (DOPs)
BLOCK DATA	Contains various parameter values used in the program
VECTOR(V1,I,V2,V3)	Performs vector additions, subtractions, and cross products
DOT(V1,V2)	Function which calculates dot product of two vectors
UNIVEC(V,UV)	Calculates unit vectors
TALL(MAX,MXX,MATRIX)	Sets up the sequence of navsats which are to be examined, using all satellites taken four at a time
SATDEL(P,PER,NJ,ND,JDEL)	Deletes specified satellites from the nominal constellation

Appendix C

Computer Program Listing

TABLE XIX

COMPUTER PROGRAM LISTING

```
      PROGRAM NAVSAT
*****************************************************************
*****************************************************************
**                                                             **
**                                                             **
**    THIS PROGRAM IS A MODIFICATION OF A COMPUTER PROGRAM BY  **
**   THE RAND CORPORATION ON THE GEOMETRIC PERFORMANCE OF PSEUDO-  **
**   RANGING NAVIGATION SATELLITE SYSTEMS, DEVELOPED FOR THE USAF. **
*****************************************************************
**                                                             **
**              NAVSTAR (GPS) ANALYSIS PROGRAM                 **
**                   (A THESIS PROJECT)                        **
**                          BY                                 **
**                                                             **
**                 CAPT DAVID W. THOMIN                        **
**                         1984                                **
*****************************************************************
*****************************************************************

C                 *******  MAIN  PROGRAM  *******
C
      COMMON/ORBIS/P(37,25)/CON/C(18)
      DIMENSION AA(3),G(37,4),IOS(37),ISIC(4),KXX(10626,4),NSGD(37),A(3)
     1,AF(3),AMX(37,3),SIGT(6),U(3),UPV(3),USUV(37,3),UTS(3),UE(3),Z(3),
     2 VE(3),XN(3),ISAVE(37),IINT(37),UEL(37),IOUT(37),STN(3)
      DIMENSION QSR(36),CAG(19,18),GLEB(18),PIB(18),ACLAT(19,36),
     1 ACTOT(36),OBLAT(19,36),OBDIS(36),CL(19),MIN(19,36),MAX(19,36),
     2 CAGX(19,18),NSPL(19),SKEG(19,36,6),SKEGX(19,36,6),GLOS(6,36),
     3 CDOP(19,36,6),ISAPP(32),PER(36)
      REAL LAT,LONG,LATDEG,LADG,LAD
      DIMENSION JDEL(10)
      KTR=48
      IPRINT=0
      Z(1)=0.
      Z(2)=0.
      Z(3)=1.E+10
      NDEL=0
C
C     LOC=1; USER ON SATELLITE
C     LOC=2; USER ON GROUND AT SPECIFIED LATITUDE AND LONGITUDE
C     LOC=3; GLOBAL CALCULATIONS
C
      READ (5,*)  LOC,NJL,ISCMP,NDEL
      IF(NDEL.EQ.0) GO TO 50
      READ (5,*) (JDEL(N),N=1,NDEL)
   50 GO TO (100,110,120),LOC
C
  100 DO 105 K=1,5
      READ (5,*)  (P(N,K),N=1,NJL)
  105 CONTINUE
```

```
      READ (5,*)  (PER(N),N=1,NJL)
      IF(NDEL.NE.0) CALL SATDEL (P,PER,NJL,NDEL,JDEL)
      NJM=NJL+1
      READ (5,*)  (P(NJM,K),K=1,5)
      READ (5,*)  PER(NJM),AIN,CK
      READ (5,*)  INC,ITF
      GO TO 155
C
 110  DO 115 K=1,5
      READ (5,*)  (P(N,K),N=1,NJL)
 115  CONTINUE
      READ (5,*)  (PER(N),N=1,NJL)
      IF (NDEL.NE.0) CALL SATDEL (P,PER,NJL,NDEL,JDEL)
      READ (5,*)  ATL,ONGL,ELEVAT
      READ (5,*)  INC,ITF
      GO TO 155
C
 120  DO 125 K=1,5
      READ (5,*)  (P(N,K),N=1,NJL)
 125  CONTINUE
      READ (5,*)  (PER(N),N=1,NJL)
      IF(NDEL.NE.0) CALL SATDEL (P,PER,NJL,NDEL,JDEL)
      READ (5,*)  LATDEG,ELEVAT
      READ (5,*)  LATIC,LONIC,INC,ITF,IPFREQ,ITIME
      DO 135 MA=1,19
      CL(MA)=0.
      NSPL(MA)=0
      DO 130 MB=1,36
      MIN(MA,MB)=30
      MAX(MA,MB)=0
      DO 130 MC=1,6
      SKEGX(MA,MB,MC)=0.
      CDOP(MA,MB,MC)=0.
 130  SKEG(MA,MB,MC)=0.
      DO 135 MD=1,18
      CAGX(MA,MD)=0.
 135  CAG(MA,MD)=0.
      DO 140 MA=1,36
      DO 140 MB=1,6
 140  GLOS(MB,MA)=0.
      DO 150 MA=1,19
      ACTOT(MA)=0.
      OBDIS(MA)=0.
      DO 145 MD=1,36
      ACLAT(MA,MD)=0.
 145  OBLAT(MA,MD)=0.
 150  GLEB(MA)=0.
C
 155  CONTINUE
      PRINT 195
      PRINT 190
      DO 160 IP=1,NJL
      PRINT 215, IP,(P(IP,IV),IV=1,5),PER(IP)
 160  CONTINUE
      IF(LOC.EQ.1) PRINT 200
      IP=NJL+1
      IF(LOC.EQ.1) PRINT 215, IP,(P(IP,IV),IV=1,5),PER(IP)
      IF(LOC.EQ.2) PRINT 210, ATL,ONGL,ELEVAT
```

```
      IF(LOC.EQ.3) PRINT 205, ELEVAT,LATDEG,LATIC,LONIC,ITIME
      ITT=(ITF-1)*INC
      PRINT 220, ITT,INC
      IF(LOC.EQ.1) PRINT 225, AIN,CK
      IF(LOC.EQ.1.AND.ISCMP.EQ.0) PRINT 166
      IF(LOC.NE.1.AND.ISCMP.EQ.0) PRINT 165
      IF(ISCMP.EQ.1) PRINT 170
C
C  THE FOLLOWING FORMATS HAVE TO DO WITH INPUT
C
 165  FORMAT(1H0,10X,'THE SATELLITE MOST NEARLY OVERHEAD IS USED AS ONE
     1OF THE FOUR'/,11X,'IN ALL CALCULATIONS OF THE VOLUME OF THE TETRAH
     2EDRON')
 166  FORMAT(1H0,10X,'THE SATELLITE MOST NEARLY ABOVE OR BELOW IS USED A
     1S ONE OF THE FOUR'/,11X,'IN ALL CALCULATIONS OF THE VOLUME OF THE
     2TETRAHEDRON')
 170  FORMAT(1H0,10X,'ALL SATELLITES, TAKEN FOUR AT A TIME, ARE USED IN'
     1,/,11X,'THE CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON')
 175  FORMAT(10I5)
 180  FORMAT(12F6.0)
 185  FORMAT(7F10.0)
 190  FORMAT(1H0,22X,' ECC',5X,'ARGP',4X,'RASC',4X,'INC',5X,'ANOM',4X,
     1'PER',//)
 195  FORMAT(1H1,//32X,'ORBITAL ELEMENTS')
 200  FORMAT(1H0,10X,'USER SATELLITE ORBITAL ELEMENTS'/)
 205  FORMAT(1H0,10X,'GLOBAL DISTRIBUTION CALCULATIONS',//,
     1 11X,'MASKING ANGLE = ',F6.2,' DEGREES',/,
     2 11X,'LATITUDE STEP = ',F6.2,' DEGREES',/,
     3 11X,'LATITUDE INCREMENT = ',I3,/,
     4 11X,'LONGITUDE INCREMENT = ',I3,/,
     5 11X,'DILUTION OF PRECISION PARAMETERS PRINTED AT TIME INCREMENT O
     6F ',I5)
 210  FORMAT(1H0,10X,'USER LOCATION ON EARTH',/11X,
     1      'LATITUDE = ',F5.2,' DEGREES'/,11X,'LONGITUDE = ',F5.2,
     2      ' DEGREES',/, 11X,'MASKING ANGLE = ',F6.2,' DEGREES')
 215  FORMAT(1H ,15X,I3,1X,F8.3,5F8.2)
 220  FORMAT(1H0,10X,'TOTAL TIME(MIN) = ',I5,/,11X,
     1   'TIME INCREMENT(MIN) = ',I3)
 225  FORMAT(1H ,10X,'BEAMWIDTH ANGLE(DEG) = ',F6.2,/,11X,
     1  'FRACTION OF NAVSAT SPHERICAL AREA = ',F6.3)
C
C   SET UP ORBITAL ELEMENTS
C
      DO 230 N=1,NJL
      P(N,22)=22808.*(PER(N)/24.)**(2./3.)
      CALL ORBINI (N)
 230  CONTINUE
      IF(LOC.EQ.2.OR.LOC.EQ.3) GO TO 235
      P(IP,22)=22808.*(PER(IP)/24.)**(2./3.)
      CALL ORBINI (IP)
 235  CONTINUE
      INCA=0
      NSTO=0
      MAXNSS=0
      DO 625 IT=1,ITF
      TID=FLOAT(INCA)/1440.
      ITOUT=(IT-1)*INC
      INCA=INCA+INC
```

```
      NN=IP
      IF(LOC.EQ.2.OR.LOC.EQ.3) NN=NJL
      DO 240 N=1,NN
      CALL ORBIT (N,TID,PER,RF,VE,RA)
      DO 240 IV=1,3
      RMX(N,IV)=RF(IV)
 240  CONTINUE
      IF(LOC.EQ.2) GO TO 335
      IF(LOC.EQ.3) GO TO 330
C
C
      DO 245 IV=1,3
      UPV(IV)=RMX(IP,IV)
 245  CONTINUE
      IK=0
      BETAMN=4.000000
      DO 265 N=1,NJL
      DO 250 IV=1,3
      R(IV)=RMX(N,IV)
 250  CONTINUE
      CALL VECTOR (R,2,UPV,UTS)
      AR=SQRT(DOT(R,R))
      AP=SQRT(DOT(UPV,UPV))
      A=ACOS(2.0926144E+07/AR)
      IF(AP.LE.2.0926144E+07) PRINT 251
 251  FORMAT(1H ,/,3X,'TERMINATION OF RUN, ALTITUDE APPROACHING ZERO')
      IF(AP.LE.2.0926144E+07) STOP
      B=ACOS(2.0926144E+07/AP)
      PHI=A+B
      DOTRP=DOT(R,UPV)
      THETN=ACOS(DOTRP/(AR*AP))
      IF(THETN.GE.PHI) GO TO 265
      AU=SQRT(DOT(UTS,UTS))
      DOTUP=DOT(UTS,UPV)
      BETAN=ACOS(-DOTUP/(AU*AP))
      AIWID=AIN/C(2)
      BWIDTH=C(3)-(THETN+BETAN)
      IF(AIWID.LT.BWIDTH) GO TO 265
      IK=IK+1
      ISAVE(IK)=N
      BETASV=BETAN
      IF(BETAN.GT.C(5)) BETAN=C(3)-BETAN
 255  IF(BETAN.LT.BETAMN) GO TO 260
      GO TO 265
 260  ISATNO=N
      BETAMN=BETAN
      BETAS=BETASV
 265  CONTINUE
      IF(IK.LT.4) GO TO 622
      DO 285 I=1,IK
      IF(ISAVE(I).EQ.ISATNO) GO TO 270
      GO TO 285
 270  INDX=I
      DO 275 KI=1,INDX
      KII=KI+1
      IINT(KII)=ISAVE(KI)
 275  CONTINUE
      INDX=INDX+1
```

```
      DO 280 KI=INDX,IK
      IINT(KI)=ISAVE(KI)
 280  CONTINUE
      GO TO 290
 285  CONTINUE
 290  IINT(1)=ISATNO
      IF(ISCMP.EQ.1) GO TO 335
C
C   THE NUMBERS OF THE SATELLITES WHICH FIT CRITERIA FOR USE, PLUS THE
C   ONE NEAREST TO OVERHEAD HAVE BEEN CALCULATED
C
      IOS(1)=IINT(1)
      NSS=1
      DO 295 IV=1,3
      R(IV)=AMX(IINT(1),IV)
 295  CONTINUE
      CALL VECTOR (R,2,UPV,UTS)
      CALL UNIVEC (UTS,U)
      DO 300 IV=1,3
      USUV(IINT(1),IV)=U(IV)
 300  CONTINUE
      DO 325 N=2,IK
      DO 305 IV=1,3
      R(IV)=AMX(IINT(N),IV)
 305  CONTINUE
      CALL VECTOR (R,2,UPV,UTS)
      CALL UNIVEC (UTS,U)
      DO 310 IV=1,3
      USUV(IINT(N),IV)=U(IV)
 310  CONTINUE
      AR=SQRT(DOT(R,R))
      AP=SQRT(DOT(UPV,UPV))
      IF(AP.GT.AR) THETT=ACOS(AR/AP)
      IF(AP.LE.AR.AND.BETAS.GT.C(5)) THETT=109.5/C(2)-ASIN(AP*.33380686/
     1AR)
      IF(AP.LE.AR.AND.BETAS.LE.C(5)) THETT=70.5/C(2)-ASIN(AP*.33380686/A
     1R)
      DOTRP=DOT(R,UPV)
      THETN=ACOS(DOTRP/(AR*AP))
      SINTT=SIN(THETT)
      SINTSQ=SINTT**2
      IF(SINTSQ.GT.CK) GO TO 315
      DELONE=THETT
      ANG=1.-(CK/.5)
      DELTWO=ACOS(ANG)-THETT
      GO TO 320
 315  CONTINUE
      DELONE=ASIN(CK/SINTT)
      DELTWO=DELONE
 320  IF(THETN.LT.(THETT-DELONE)) GO TO 325
      IF(THETN.GT.(THETT+DELTWO)) GO TO 325
      NSS=NSS+1
      IOS(NSS)=IINT(N)
 325  CONTINUE
      IF(NSS.LE.4) GO TO 625
      GO TO 335
C
```

```
C    END OF USER ON SATELLITE
C
C    CALCULATIONS FOR USER ON EARTH AT SPECIFIED LAT AND LONG, AND
C    GLOBAL DISTRIBUTIUONS FOLLOW
 330  CONTINUE
      LKL=36
      LLL=19
 335  CONTINUE
      IF(LOC.EQ.2.OR.LOC.EQ.1) LKL=1
      IF(LOC.EQ.2.OR.LOC.EQ.1) LLL=1
      DO 500 K=1,LKL,LONIC
      DO 500 L=1,LLL,LATIC
      IF(LOC.EQ.1.AND.ISCMP.EQ.0) GO TO 401
      IF(LOC.EQ.1.AND.ISCMP.EQ.1) GO TO 375
      LONG=FLOAT(K-1)*10.
      LAT=90.-FLOAT(L-1)*LATDEG
      IF(LOC.EQ.2) LONG=ONGL
      IF(LOC.EQ.2) LAT=ATL
      CALL POINT (LONG,LAT,TID,UPV)
      NSS=0
      CL(L)=CL(L)+1.
      DO 350 N=1,NJL
      DO 340 IV=1,3
      A(IV)=AMX(N,IV)
 340  CONTINUE
      CALL VECTOR (UPV,2,A,STN)
      SE=-DOT(STN,UPV)/SQRT(DOT(STN,STN)*DOT(UPV,UPV))
      IF(ABS(SE).GE..9999999) SE=SIGN(1.,SE)
      EL=ASIN(SE)*C(2)
      IF(EL.LT.ELEVAT) GO TO 350
      NSS=NSS+1
      IINT(NSS)=N
      UEL(N)=EL
      CALL VECTOR (A,2,UPV,UTS)
      CALL UNIVEC (UTS,U)
      DO 345 IV=1,3
      USUV(N,IV)=U(IV)
 345  CONTINUE
 350  CONTINUE
 355  CONTINUE
      NSTO=NSTO+NSS
      NSPL(L)=NSPL(L)+NSS
      NSP=NSS+1
      MAXNSS=MAX0(MAXNSS,NSS)
      HIGH=0.
      DO 365 NUM=1,NSS
      IX=IINT(NUM)
      AEA=UEL(IX)
      IF(AEA.GT.HIGH) GO TO 360
      IF(AEA.LE.HIGH) GO TO 365
 360  HIGH=AEA
      NN=NUM
 365  CONTINUE
      DO 370 NU=1,NSS
      IF(NU.EQ.NN) NX=1
      IF(NU.LT.NN) NX=NU+1
      IF(NU.GT.NN) NX=NU
      IOS(NX)=IINT(NU)
```

```
 370  CONTINUE
      GO TO 400
C
C  IOS(NSS) HAS THE SATELLITE NEAREST TO OVERHEAD, THEN ALL OTHERS
C  WHICH FIT CRITERIA
C
C  NEXT CALCULATIONS ARE CONCERNED WITH FINDING THE COMBINATION OF
C  FOUR SATELLITES WHICH HAVE THE GREATEST VALUE OF THE VOLUME OF THE
C  TETRAHEDRON FORMED BY THEM
C
 375  CONTINUE
      DO 390 IKN=1,IK
      DO 380 IV=1,3
      R(IV)=AMX(IINT(IKN),IV)
 380  CONTINUE
      CALL VECTOR (R,2,UPV,UTS)
      CALL UNIVEC (UTS,U)
      DO 385 IV=1,3
      USUV(IINT(IKN),IV)=U(IV)
 385  CONTINUE
 390  CONTINUE
      DO 395 IJK=1,IK
 395  IOS(IJK)=IINT(IJK)
      GO TO 401
 400  IF(NSS.LT.4) GO TO 479
 401  BOX=-10.
      IF(ISCMP.EQ.1) GO TO 405
      KOT=NSS
      NSS=NSS-1
      CALL TRAT (NSS,KCOM,KXX)
      ISIC(1)=IOS(1)
      LPN=2
      GO TO 410
 405  KOT=IK
      IF(LOC.EQ.2.OR.LOC.EQ.3) KOT=NSS
      CALL TALL (KOT,KCOM,KXX)
      LPN=1
 410  DO 430 M=1,KCOM
      DO 415 LPQ=LPN,4
      NUX=KXX(M,LPQ)
      ISIC(LPQ)=IOS(NUX)
 415  CONTINUE
      CALL VOLUME (USUV,ISIC,VOLUM)
      IF(VOLUM.GT.BOX) GO TO 420
      IF(VOLUM.LE.BOX) GO TO 430
 420  BOX=VOLUM
      DO 425 MC=1,4
      NSGD(MC)=ISIC(MC)
 425  CONTINUE
 430  CONTINUE
      DO 440 N=1,4
      DO 435 IV=1,3
      R(IV)=AMX(NSGD(N),IV)
 435  CONTINUE
      CALL VECTOR (R,2,UPV,UTS)
      CALL VECTOR (Z,3,UPV,YE)
      CALL VECTOR (UPV,3,YE,XN)
      AX=SQRT(DOT(XN,XN))
```

```
      AY=SQRT(DOT(YE,YE))
      AP=SQRT(DOT(UPV,UPV))
      ALT=AP/6076.116-3444.
      AS=SQRT(DOT(UTS,UTS))
      G(NSGD(N),1)=DOT(XN,UTS)/(AX*AS)
      G(NSGD(N),2)=DOT(YE,UTS)/(AY*AS)
      G(NSGD(N),3)=DOT(UPV,UTS)/(AP*AS)
      G(NSGD(N),4)=1.
 440  CONTINUE
      CALL COVNAV (G,NSGD,4,SIGT)
      IF(LOC.EQ.3) GO TO 480
      IF(LOC.EQ.2) ALT=0.
      DO 445 II=1,4
      IOUT(II)=NSGD(II)
 445  CONTINUE
      IL=1
      LK=4
      DO 455 NN=1,KOT
      ITST=NSGD(IL)
      IF(ITST.EQ.IOS(NN)) GO TO 450
      LK=LK+1
      IOUT(LK)=IOS(NN)
      GO TO 455
 450  IL=IL+1
      IF(IL.EQ.5) GO TO 460
 455  CONTINUE
 460  KOS=NN+1
      DO 465 LK=KOS,KOT
      IOUT(LK)=IOS(LK)
 465  CONTINUE
      ITOUT=(IT-1)*INC
      KTR=KTR+2
      IF(KOT.GT.18) KTR=KTR+1
      IF(KTR.GE.40) GO TO 470
      GO TO 475
 470  PRINT 525
      KTR=0
 475  PRINT 530, ITOUT,ALT,(SIGT(KP),KP=1,6),(IOUT(KP),KP=1,KOT)
C
C  END OF CALCULATION FOR SINGLE USER ON EARTH
C
      GO TO 625
C
C  FOLLOWING CALCULATIONS FOR GLOBAL DISTRIBUTION
C
 479  KOT=NSS
      SIGT(1)=1000.
      SIGT(2)=1000.
      SIGT(3)=1000.
      SIGT(4)=1000.
      SIGT(5)=1000.
      SIGT(6)=1000.
 480  DO 485 IDOP=1,6
 485  CDOP(L,K,IDOP)=SIGT(IDOP)
      DO 490 NS=1,6
      KA=MAX0(1,MIN0(INT(SIGT(NS)*5.+1.),36))
 490  SKEG(L,KA,NS)=SKEG(L,KA,NS)+1.
      DO 495 NA=1,KOT
```

```
      I=IOS(NA)
      ELT=UEL(I)
      KO=MINO(INT(ELT/5.)+1,18)
  495 CAG(L,KO)=CAG(L,KO)+1.
      MAX(L,K)=MAXO(MAX(L,K),KOT)
      MIN(L,K)=MINO(MIN(L,K),KOT)
      OBLAT(L,NSP)=OBLAT(L,NSP)+1.
  500 CONTINUE
      IF(LOC.EQ.3.AND.IPFREQ.EQ.0) GO TO 625
C                                        NO INTERMEDIATE PRINT
      IF(IPRINT.EQ.0.AND.IT.EQ.1) GO TO 505
C                                        PRINT FIRST TIME STEP
      IPRINT=IPRINT+1
      IF(IPRINT.EQ.ITIME) GO TO 505
C                                      PRINT EACH TIME STEP REQUESTED
      GO TO 625
  505 IPRINT=0
      DO 515 IDOP=1,6
      IF(IDOP.EQ.1) PRINT 535, ITOUT
      IF(IDOP.EQ.2) PRINT 540, ITOUT
      IF(IDOP.EQ.3) PRINT 545, ITOUT
      IF(IDOP.EQ.4) PRINT 550, ITOUT
      IF(IDOP.EQ.5) PRINT 555, ITOUT
      IF(IDOP.EQ.6) PRINT 560, ITOUT
      IF(LATDEG.EQ.10.) PRINT 565
      IF(LATDEG.EQ.5.) PRINT 570
      ICT=-10
      DO 510 IC=1,36
      ICT=ICT+10
      IF(ICT.LE.90.OR.ICT.GE.190) PRINT 575, ICT,(CDOP(IK,IC,IDOP),IK
     1=1,19)
      IF(ICT.EQ.100) PRINT 580, (CDOP(IK,IC,IDOP),IK=1,19)
      IF(ICT.EQ.110) PRINT 585, (CDOP(IK,IC,IDOP),IK=1,19)
      IF(ICT.EQ.120) PRINT 590, (CDOP(IK,IC,IDOP),IK=1,19)
      IF(ICT.EQ.130) PRINT 595, (CDOP(IK,IC,IDOP),IK=1,19)
      IF(ICT.EQ.140) PRINT 600, (CDOP(IK,IC,IDOP),IK=1,19)
      IF(ICT.EQ.150) PRINT 605, (CDOP(IK,IC,IDOP),IK=1,19)
      IF(ICT.EQ.160) PRINT 610, (CDOP(IK,IC,IDOP),IK=1,19)
      IF(ICT.EQ.170) PRINT 615, (CDOP(IK,IC,IDOP),IK=1,19)
      IF(ICT.EQ.180) PRINT 620, (CDOP(IK,IC,IDOP),IK=1,19)
  510 CONTINUE
  515 CONTINUE
      DO 520 ICL=1,19
      DO 520 ICK=1,36
      DO 520 ICD=1,6
  520 CDOP(ICL,ICK,ICD)=0.
C
C   THE FOLLOWING FORMATS HAVE TO DO WITH A SPECIFIED TIME STEP
C   REQUEST FOR PRINTING
C
  525 FORMAT(1H1,/,1X,'TIME(MN)',1X,'ALT(NM)',4X,'VDOP',
     1 5X,'HDOP',5X,'MDOP',5X,'TDOP',5X,'PDOP',5X,'GDOP',4X,
     2      'SATELLITES CHOSEN',//)
  530 FORMAT(1H0,I7,F9.0,6(F9.3),1X,19(1X,I2),/,72X,17(1X,I2))
  531 FORMAT(1H0,I7,F9.0,'    ONLY   ',I4,' SATELLITES ARE VISIBLE.')
  535 FORMAT(1H1,//,10X,'TIME = ',I6,20X,'VDOP - ALTITUDE')
  540 FORMAT(1H1,//,10X,'TIME = ',I6,20X,'HDOP - POSITION ERROR IN HORIZ
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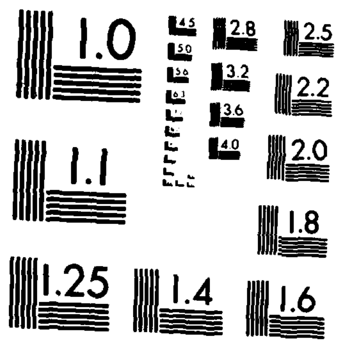
AD-A151 692 GLOBAL POSITIONING SYSTEM - A MODIFICATION TO THE BASELINE SATELLITE CONS..(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF ENGI.. D W THOMIN 2/3

UNCLASSIFIED DEC 84 AFIT/GA/ENG/84D-4 F/G 17/7 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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      IONTAL PLANE')
  545 FORMAT(1H1,//,10X,'TIME = ',I6,20X,'HDOP - LARGER COMPONENT OF POS
     1ITION ERROR')
  550 FORMAT(1H1,//,10X,'TIME = ',I6,20X,'TDOP - TIME')
  555 FORMAT(1H1,//,10X,'TIME = ',I6,20X,'PDOP - THREE DIMENSIONAL POSIT
     1ION ERROR')
  560 FORMAT(1H1,//,10X,'TIME = ',I6,20X,'GDOP - FOUR DIMENSIONAL POSITI
     1ON ERROR')
  565 FORMAT(1H0,52X,'LATITUDE',//,9X,' 90',3X,' 80',3X,' 70',3X,' 60',
     1 3X,' 50',3X,' 40',3X,' 30',3X,' 20',3X,' 10',3X,'  0',3X,'-10',
     2 3X,'-20',3X,'-30',3X,'-40',3X,'-50',3X,'-60',3X,'-70',3X,'-80',
     3 3X,'-90',/)
  570 FORMAT(1H0,52X,'LATITUDE',//,9X,' 90',3X,' 85',3X,' 80',3X,' 75',
     1 3X,' 70',3X,' 65',3X,' 60',3X,' 55',3X,' 50',3X,' 45',3X,' 40',
     2 3X,' 35',3X,' 30',3X,' 25',3X,' 20',3X,' 15',3X,' 10',3X,'  5',
     3 3X,'  0',/)
  575 FORMAT(1H ,2X,I3,1X,19F6.2)
  580 FORMAT(1H ,'L',1X,'100',1X,19F6.2)
  585 FORMAT(1H ,'O',1X,'110',1X,19F6.2)
  590 FORMAT(1H ,'N',1X,'120',1X,19F6.2)
  595 FORMAT(1H ,'G',1X,'130',1X,19F6.2)
  600 FORMAT(1H ,'I',1X,'140',1X,19F6.2)
  605 FORMAT(1H ,'T',1X,'150',1X,19F6.2)
  610 FORMAT(1H ,'U',1X,'160',1X,19F6.2)
  615 FORMAT(1H ,'D',1X,'170',1X,19F6.2)
  620 FORMAT(1H ,'E',1X,'180',1X,19F6.2)
C
  622 ITOUT=(IT-1)*INC
      ALT=AP/6076.116-3444.
      KTR=KTR+2
      IF (KTR.GE.40) GO TO 623
      GO TO 624
  623 PRINT 525
      KTR=0
  624 PRINT 531,ITOUT,ALT,IK
  625 CONTINUE
      IF(LOC.EQ.1.OR.LOC.EQ.2) GO TO 920
      MNSSPO=MAXNSS+1
      DO 630 LI=1,36
  630 QSA(LI)=FLOAT(LI-1)*.2
      DO 640 IX=1,18
      PIB(IX)=0.
      DO 635 IY=1,19
  635 PIB(IX)=PIB(IX)+CAG(IY,IX)
  640 PIB(IX)=(PIB(IX)/FLOAT(NSTO))*100.
      DO 661 LA=1,19
      IF(CL(LA).EQ.0..OR.NSPL(LA).EQ.0) GO TO 661
      DO 650 N=1,36
      DO 650 I=1,6
      SKEGX(LA,N,I)=0.
      DO 645 J=N,36
  645 SKEGX(LA,N,I)=SKEGX(LA,N,I)+SKEG(LA,J,I)
  650 SKEGX(LA,N,I)=SKEGX(LA,N,I)/CL(LA)
      DO 660 LC=1,18
      CAGX(LA,LC)=0.
      DO 655 LF=LC,18
  655 CAGX(LA,LC)=CAGX(LA,LC)+CAG(LA,LF)
      CAGX(LA,LC)=CAGX(LA,LC)/FLOAT(NSPL(LA))
```

```
660  CONTINUE
661  CONTINUE

     PRINT 780
     PRINT 785, (PIB(IX),IX=1,18)
     IF(LATDEG.EQ.5.) PRINT 795
     IF(LATDEG.EQ.10.) PRINT 800
     ICT=-5
     DO 665 LC=1,18
     ICT=ICT+5
     PRINT 815,ICT,(CAGX(LA,LC),LA=1,19)
665  CONTINUE
     CVS=0.
     DO 680 LM=1,19
     IF(CL(LM).EQ.0..OR.NSPL(LM).EQ.0) GO TO 680
     CV=COS((90.-FLOAT(LM-1)*LATDEG)*C(1))
     CVS=CVS+CV
     DO 670 IN=1,6
     DO 670 II=1,36
670  GLOS(IN,II)=GLOS(IN,II)+SKEGX(LM,II,IN)*CV
     DO 675 LN=1,18
675  GLEB(LN)=GLEB(LN)+CAGX(LM,LN)*CV
680  CONTINUE
     DO 685 LN=1,18
685  GLEB(LN)=GLEB(LN)/CVS
     PRINT 805
     PRINT 810, (GLEB(IC),IC=1,18)
     DO 690 IN=1,6
     DO 690 II=1,36
690  GLOS(IN,II)=GLOS(IN,II)/CVS
     DO 695 JDOP=1,6
     IF(JDOP.EQ.1) PRINT 830
     IF(JDOP.EQ.2) PRINT 835
     IF(JDOP.EQ.3) PRINT 840
     IF(JDOP.EQ.4) PRINT 845
     IF(JDOP.EQ.5) PRINT 850
     IF(JDOP.EQ.6) PRINT 855
     IF(LATDEG.EQ.10.) PRINT 820
     IF(LATDEG.EQ.5.) PRINT 825
     DO 695 IQSR=1,36
     PRINT 775, QSR(IQSR),(SKEGX(LK,IQSR,JDOP),LK=1,19)
695  CONTINUE
     PRINT 860
     DO 700 IQSR=1,36
     PRINT 865, QSR(IQSR),(GLOS(IN,IQSR),IN=1,6)
700  CONTINUE
     PRINT 870
     LADG=90.
     IF(LATDEG.EQ.10.) LAD=-10.
     IF(LATDEG.EQ.5.) LAD=-5.
     PRINT 880
     DO 705 IL=1,19
     PRINT 885, LADG,(MAX(IL,IK),IK=1,36)
     LADG=LADG+LAD
705  CONTINUE
     PRINT 875
```

```
      LADG=90.
      DO 715 IL=1,19
      DO 710 IX=1,36
      IF(MIN(IL,IX).EQ.30) MIN(IL,IX)=0
710   CONTINUE
      PRINT 885, LADG,(MIN(IL,IK),IK=1,36)
      LADG=LADG+LAD
715   CONTINUE
      DO 720 N=1,MNSSPO
      OBDIS(N)=0.
      DO 720 L=1,19
      IF(CL(L).EQ.0..OR.NSPL(L).EQ.0) GO TO 720
      OBLAT(L,N)=(OBLAT(L,N)/CL(L))*100.
720   CONTINUE
      DO 730 L=1,19
      DO 730 N=1,MNSSPO
      ACLAT(L,N)=0.
      DO 725 M=N,MNSSPO
725   ACLAT(L,N)=ACLAT(L,N)+OBLAT(L,M)
730   CONTINUE
      CO=0.
      DO 740 L=1,19
      IF(CL(L).EQ.0..OR.NSPL(L).EQ.0) GO TO 740
      CA=COS((90.-FLOAT(L-1)*LATDEG)*C(1))
      CO=CO+CA
      DO 735 N=1,MNSSPO
735   OBDIS(N)=OBDIS(N)+OBLAT(L,N)*CA
740   CONTINUE
      DO 745 N=1,MNSSPO
745   OBDIS(N)=OBDIS(N)/CO
      DO 750 N=1,MNSSPO
      ACTOT(N)=0.
      DO 750 M=N,MNSSPO
750   ACTOT(N)=ACTOT(N)+OBDIS(M)
      DO 755 I=1,32
      ISAPP(I)=I-1
755   CONTINUE
      NP=1
      MNS=MNSSPO
      IF (MNSSPO.GT.16) MNS=16
      PRINT 890, (ISAPP(I),I=1,16)
760   PRINT 900
      LADG=90.
      DO 765 IL=1,19
      PRINT 895, LADG,(OBLAT(IL,N),N=NP,MNS)
      LADG=LADG+LAD
765   CONTINUE
      PRINT 905
      LADG=90.
      DO 770 IL=1,19
      PRINT 895, LADG,(ACLAT(IL,N),N=NP,MNS)
      LADG=LADG+LAD
770   CONTINUE
      PRINT 910
      PRINT 790, (OBDIS(N),N=NP,MNS)
      PRINT 915
      PRINT 790, (ACTOT(N),N=NP,MNS)
```

```
      IF(MNSSPO.LT.16) GO TO 920
      IF(MNS.GT.16) GO TO 920
      MNS=MNSSPO
      NP=17
      PRINT 890, (ISAPP(I),I=17,32)
      GO TO 760
C
C  THE FOLLOWING FORMATS HAVE TO DO WITH A GLOBAL SYSTEM
C
 775  FORMAT(1H ,F4.1,3X,19F6.3)
 780  FORMAT(1H1,/////1X,'ELEVATION DISTRIBUTION - PROBABILITY THAT THE
     1SATELLITE IN VIEW WILL HAVE ELEVATION ANGLES AS LISTED',//,48X,
     2 'ELEVATION ANGLE')
 785  FORMAT(1H0,6X,'   0-5  5-10 10-15 15-20 20-25 25-30 30-35 35-40 40
     1-45 45-50 50-55 55-60 60-65 65-70 70-75 75-80 80-85 85-90',//,2X,
     2 'PROB',1X,18F6.1)
 790  FORMAT(1H0,3X,'PROB',5X,18F7.2)
 795  FORMAT(1H0,////,1X,'LATITUDE ELEVATION DISTRIBUTION',/,
     1     1X,'PROBABILITY THAT ANY SATELLITE IN VIEW WILL HAVE AN ELEVAT
     2ION ANGLE GREATER THAN OR EQUAL TO THOSE LISTED',//,52X,
     3'LATITUDE',/,2X,'ELEV',/,1X,'ANGLE',   1X,'     90     85     80     75
     4     70     65     60     55     50     45     40     35     30     25     20
     5     15     10      5      0',/)
 800  FORMAT(1H0,////,1X,'LATITUDE ELEVATION DISTRIBUTION',/,
     1     1X,'PROBABILITY THAT ANY SATELLITE IN VIEW WILL HAVE AN ELEVAT
     2ION ANGLE GREATER THAN OR EQUAL TO THOSE LISTED',//,52X,
     3'LATITUDE',/,2X,'ELEV',/,1X,'ANGLE',   1X,'     90     80     70     60
     4     50     40     30     20     10      0    -10    -20    -30    -40    -50
     5    -60    -70    -80    -90',/)
 805  FORMAT(1H0,////,1X,'ACCUMULATIVE ELEVATION DISTRIBUTION',/,
     11X,'PROBABILITY THAT THE ELEVATION ANGLE IS GREATER THAN OR EQUAL
     2TO THOSE LISTED',//,48X,'ELEVATION ANGLE')
 810  FORMAT(1H0,7X,'     0      5     10     15     20     25     30     35     4
     10     45     50     55     60     65     70     75     80     85',//,2X,
     2 'PROB',1X,18F6.1)
 815  FORMAT(1H ,I3,4X,19F6.2)
 820  FORMAT(1H0,52X,'LATITUDE',//,2X,'NUM',5X,
     1                                    ' 90',3X,' 80',3X,' 70',3X,' 60',
     2 3X,' 50',3X,' 40',3X,' 30',3X,' 20',3X,' 10',3X,'  0',3X,'-10',
     3 3X,'-20',3X,'-30',3X,'-40',3X,'-50',3X,'-60',3X,'-70',3X,'-80',
     4 3X,'-90',/)
 825  FORMAT(1H0,52X,'LATITUDE',//,2X,'NUM',5X,
     1                                    ' 90',3X,' 85',3X,' 80',3X,' 75',
     2 3X,' 70',3X,' 65',3X,' 60',3X,' 55',3X,' 50',3X,' 45',3X,' 40',
     3 3X,' 35',3X,' 30',3X,' 25',3X,' 20',3X,' 15',3X,' 10',3X,'  5',
     4 3X,'  0',/)
 830  FORMAT(1H1,///,1X,'DILUTION OF PRECISION - ACCUMULATIVE LATITUDE D
     1ISTRIBUTION',/,1X,'PROBABILITY THAT ALTITUDE DOP WILL BE GREATER T
     2HAN NUMBER LISTED',//)
 835  FORMAT(1H1,///,1X,'DILUTION OF PRECISION - ACCUMULATIVE LATITUDE D
     1ISTRIBUTION',/,1X,'PROBABILITY THAT POSITION DOP IN HORIZONTAL PLA
     2NE WILL BE GREATER THAN NUMBER LISTED',//)
 840  FORMAT(1H1,///,1X,'DILUTION OF PRECISION - ACCUMULATIVE LATITUDE D
     1ISTRIBUTION',/,1X,'PROBABILITY THAT LARGER COMPONENT OF POSITION D
     2OP WILL BE GREATER THAN NUMBER LISTED',//)
 845  FORMAT(1H1,///,1X,'DILUTION OF PRECISION - ACCUMULATIVE LATITUDE D
     1ISTRIBUTION',/,1X,'PROBABILITY THAT TIME DOP WILL BE GREATER THAN
     2NUMBER LISTED',//)
```

```
850  FORMAT(1H1,///,1X,'DILUTION OF PRECISION - ACCUMULATIVE LATITUDE D
    1ISTRIBUTION',/,1X,'PROBABILITY THAT THREE DIMENSIONAL POSITION DOP
    2 WILL BE GREATER THAN NUMBER LISTED',//)
855  FORMAT(1H1,///,1X,'DILUTION OF PRECISION - ACCUMULATIVE LATITUDE D
    1ISTRIBUTION',/,1X,'PROBABILITY THAT FOUR DIMENSIONAL POSITION DOP
    2WILL BE GREATER THAN NUMBER LISTED',//)
860  FORMAT(1H1,///,1X,'DILUTION OF PRECISION PARAMETERS - ACCUMULATIVE
    1 GLOBAL DISTRIBUTION',//,8X,'NUMBER',7X,'VDOP',6X,'HDOP',6X,
    2  'HDOP',6X,'TDOP',6X,'PDOP',6X,'GDOP',/)
865  FORMAT(1H ,9X,F3.1,3X,6F10.4)
870  FORMAT(1H1,1X,' MAXIMUM AND MINIMUM NUMBERS SEEN AT EACH LATITUDE
    1& LONGITUDE')
875  FORMAT(1H0,/,38X,'MINIMUM',//,37X,'LONGITUDE',//,
    1 32X,2('1',9X),2('2',9X),2('3',9X),/,22X,3('5',9X,'0',9X),
    2 '5',/,5X,'LAT',4X,8('0',9X),/)
880  FORMAT(1H0,/,38X,'MAXIMUM',//,37X,'LONGITUDE',//,
    1 32X,2('1',9X),2('2',9X),2('3',9X),/,22X,3('5',9X,'0',9X),
    2 '5',/,5X,'LAT',4X,8('0',9X),/)
885  FORMAT(1H ,3X,F4.0,3X,36I2)
890  FORMAT(1H1,40X,'NUMBER OF SATELLITES',//,5X,'LAT',3X,16I7)
895  FORMAT(1H ,3X,F4.0,5X,16F7.2)
900  FORMAT(1H0,/,10X,'PROBABILITY (IN PERCENT) OF SEEING EXACTLY N SAT
    1ELLITES',/)
905  FORMAT(1H0,/,10X,'PROBABILITY (IN PERCENT) OF SEEING N OR MORE SAT
    1ELLITES',/)
910  FORMAT(1H0,/,1X,'ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) TH
    1AT EXACTLY N SATELLITES WILL BE SEEN')
915  FORMAT(1H0,/,1X,'ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) TH
    1AT N OR MORE SATELLITES WILL BE SEEN')
920  CONTINUE
     END
```

****
****

```
********************************************************************
********************************************************************
      SUBROUTINE ORBINI(I)
      COMMON/ORBIS/P(37,25)/CON/C(18)
      P(I,2)=P(I,2)*C(1)
      P(I,3)=P(I,3)*C(1)
      P(I,4)=P(I,4)*C(1)
      P(I,5)=P(I,5)*C(1)
      P(I,9)=SIN(P(I,4))
      P(I,10)=COS(P(I,4))
      P(I,11)=SIN(P(I,3))
      P(I,12)=COS(P(I,3))
      P(I,21) = P(I,22)*C(6)
      SAA=22808.*C(6)
      P(I,23)=(SAA/P(I,21))**1.5
      P(I,6)=P(I,21)*(1.-P(I,1)*P(I,1))
      P(I,7)=SQRT(  C(12)/P(I,6))
      P(I,8)=C(12)/(P(I,6)*P(I,6))
      RETURN
      END
********************************************************************
********************************************************************
      SUBROUTINE ORBIT(I,T,PER,R,VEL,AC)
      COMMON/ORBIS/OP(37,25)/CON/C(18)
      DIMENSION R(3),VEL(3),AC(3),TRANS(3,3),Q(3),QEL(3),QC(3),U(36),
     1  E(36),BIGT(36),LILT(36),V(36),CV(36),SV(36),PER(36)
      REAL LILT
      IF(T.GT.0) GO TO 10
      V(I)=OP(I,5)
      SINE=(SQRT(1.-OP(I,1)**2)*SIN(OP(I,5)))/(1.+OP(I,1)*COS(OP(I,5)))
      RAD=(OP(I,22)*(1.-OP(I,1)**2))/(1.+OP(I,1)*COS(OP(I,5)))
      E(I)=ASIN(SINE)
      IF(OP(I,1).NE.0.) GO TO 15
      IF(V(I).LT.(C(3)/2.)) E(I)=E(I)
      IF((V(I).GE.(C(3)/2.)).AND.
     1  (V(I).LE.(3.*C(3)/2.))) E(I)=C(3)-E(I)
      IF(V(I).GT.(3.*C(3)/2.)) E(I)=C(4)+E(I)
      GO TO 20
15    CONTINUE
      IF(RAD.LT.OP(I,22).AND.V(I).LE.C(3)) E(I)=E(I)
      IF(RAD.GT.OP(I,22)) E(I)=C(3)-E(I)
      IF(RAD.LT.OP(I,22).AND.V(I).GT.C(3)) E(I)=C(4)+E(I)
20    CONTINUE
      BIGT(I)=(PER(I)*(E(I)-OP(I,1)*SINE))/(24.*C(4))
      LILT(I)=BIGT(I)
      GO TO 25
10    DEL=.1
      LILT(I)=BIGT(I)+T
      E(I)=0.
35    E(I)=E(I)+DEL
      Y=LILT(I)-(PER(I)*(E(I)-OP(I,1)*SIN(E(I))))/(24.*C(4))
      IF(ABS(Y).LE..00001) GO TO 30
      IF(Y.GT.0) GO TO 35
      E(I)=E(I)-DEL
      DEL=DEL/10.
      GO TO 35
30    CONTINUE
```

```
      IF(E(I).GE.C(4)) E(I)=E(I)-C(4)
      SINU=(SQRT(1.-OP(I,1)**2)*SIN(E(I)))/(1.-OP(I,1)*COS(E(I)))
      V(I)=ASIN(SINU)
      RP=OP(I,22)*(1.-OP(I,1)*COS(E(I)))
      P=OP(I,22)*(1.-OP(I,1)**2)
      IF(OP(I,1).NE.0.) GO TO 40
      IF(E(I).LT.(C(3)/2.)) V(I)=V(I)
      IF((E(I).GE.(C(3)/2.)).AND.
     1   (E(I).LE.(3.*C(3)/2.))) V(I)=C(3)-V(I)
      IF(E(I).GT.(3.*C(3)/2.)) V(I)=C(4)+V(I)
      GO TO 25
   40 CONTINUE
      IF(RP.LT.P.AND.E(I).LE.C(4)) V(I)=V(I)
      IF(RP.GT.P) V(I)=C(3)-V(I)
      IF(RP.LT.P.AND.E(I).GT.C(4)) V(I)=C(4)+V(I)
   25 CONTINUE
      CV(I)=COS(V(I))
      SV(I)=SIN(V(I))
      U(I)=V(I)+OP(I,2)
      OP(I,13)=COS(U(I))
      OP(I,14)=SIN(U(I))
      SPH=OP(I,14)*OP(I,9)
      CPH=SQRT(1.+SPH*SPH)
      OP(I,15)=ASIN(SPH)*C(2)
      OP(I,18)=U(I)
      F1=1.+OP(I,1)*CV(I)
      Q(1)=OP(I,6)/F1
      Q(2)=0.
      Q(3)=0.
      QEL(1)=OP(I,1)*OP(I,7)*SV(I)
      QEL(2)=OP(I,7)*F1
      QEL(3)=0.
      QC(1)=-OP(I,8)*F1*F1
      QC(2)=0.
      QC(3)=0.
      CALL TRMATX (TRANS,I)
      CALL MATMUL (TRANS,Q,R)
      CALL MATMUL (TRANS,QEL,VEL)
      CALL MATMUL (TRANS,QC,AC)
      OP(I,24)=(T- AINT(T+.5))*C(4)
      OP(I,16)=ATAN2(R(2),R(1))-OP(I,24)
      OP(I,16)=OP(I,16)*C(2)
      RETURN
      END
***************************************************************************
***************************************************************************
      SUBROUTINE TRMATX(TR,I)
      DIMENSION TR(3,3)
      COMMON/ORBIS/OP(37,25)/CON/C(18)
      TR(1,1)=OP(I,12)*OP(I,13)-OP(I,11)*OP(I,10)*OP(I,14)
      TR(1,2)=OP(I,12)*OP(I,14)+OP(I,11)*OP(I,10)*OP(I,13)
      TR(1,3)=OP(I,11)*OP(I,9)
      TR(2,1)= OP(I,11)*OP(I,13)+OP(I,12)*OP(I,10)*OP(I,14)
      TR(2,2)=-OP(I,11)*OP(I,14)+OP(I,12)*OP(I,10)*OP(I,13)
      TR(2,3)=-OP(I,12)*OP(I,9)
      TR(3,1)=OP(I,9)*OP(I,14)
      TR(3,2)= OP(I,9)*OP(I,13)
      TR(3,3)=OP(I,10)
```

```
      TR(1,2)=-1.*TR(1,2)
      RETURN
      END
************************************************************************
************************************************************************
      SUBROUTINE MATMUL(T,V,O)
      DIMENSION T(3,3),V(3),O(3)
      DO 10 I=1,3
      O(I)=0.
      DO 10 J=1,3
   10 O(I)=O(I)+T(I,J)*V(J)
      RETURN
      END
************************************************************************
************************************************************************
      SUBROUTINE POINT(ALO,ALA,TIM,VEC)
      COMMON/CON/C(18)
      DIMENSION VEC(3)
      EW=ALO*C(1)+C(4)*TIM
      SN=ALA*C(1)
      VEC(1)=C(10)*COS(SN)*COS(EW)
      VEC(2)=C(10)*COS(SN)*SIN(EW)
      VEC(3)=C(10)*SIN(SN)
      RETURN
      END
************************************************************************
************************************************************************
      SUBROUTINE TAAT (MAX,MXX,MATRIX)
      DIMENSION MATRIX(10626,4)
      DO 10 I=1,10626
      DO 10 II=1,4
   10 MATRIX(I,II)=0
      IF(MAX.LT.3) GO TO 30
      MXX=(MAX-2)*(MAX-1)*MAX/6
      MMM=MAX-1
      MMN=MAX
      MMO=MAX+1
      NA=0
      DO 25 K=2,MMM
      KO=K+1
      DO 20 L=KO,MMN
      KT=L+1
      DO 15 M=KT,MMO
      NA=NA+1
      MATRIX(NA,2)=K
      MATRIX(NA,3)=L
      MATRIX(NA,4)=M
   15 CONTINUE
   20 CONTINUE
   25 CONTINUE
   30 RETURN
      END
************************************************************************
************************************************************************
      SUBROUTINE VOLUME (UVEC,IDSAT,VOL)
      DIMENSION UVEC(37,3),IDSAT(4),ONE(3),TWO(3),THREE(3),FOUR(3)
      DIMENSION TMF(3),TMT(3),OMT(3),CROSS(3)
      KA=IDSAT(1)
```

```
      KB=IDSAT(2)
      KC=IDSAT(3)
      KD=IDSAT(4)
      DO 10 N=1,3
      ONE(N)=UVEC(KA,N)
      TWO(N)=UVEC(KB,N)
      THREE(N)=UVEC(KC,N)
   10 FOUR(N)=UVEC(KD,N)
      CALL VECTOR (TWO,2,FOUR,TMF)
      CALL VECTOR (THREE,2,TWO,TMT)
      CALL VECTOR (ONE,2,TWO,OMT)
      CALL VECTOR (TMT,3,TMF,CROSS)
      VOL=ABS(DOT(OMT,CROSS))
      RETURN
      END
*****************************************************************
*****************************************************************
      SUBROUTINE COVNAV (G,ID,NAT,SIG)
      DIMENSION ID(37),B(4),SIG(6),G(37,4)
      DIMENSION AINV(4,4),WKAREA(40),TRA(4,4)
      DO 20 I=1,4
      DO 15 J=1,I
      TRA(I,J)=0.
      DO 10 K=1,NAT
      L=ID(K)
      TRA(I,J)=TRA(I,J)+G(L,I)*G(L,J)
   10 CONTINUE
      TRA(J,I)=TRA(I,J)
   15 CONTINUE
      TRA(I,I)=TRA(I,I)+1.E-12
   20 CONTINUE
      CALL LINV2F (TRA,4,4,AINV,1,WKAREA,IER)
      IF(IER.EQ.129) GO TO 35
      DO 30 I=1,4
      DO 25 J=1,4
      TRA(I,J)=AINV(I,J)
      AINV(I,J)=0
   25 CONTINUE
   30 CONTINUE
      SIG(1)=SQRT(TRA(3,3))
      SIG(2)=SQRT(TRA(1,1)+TRA(2,2))
      SIG(3)=AMAX1(SQRT(TRA(1,1)),SQRT(TRA(2,2)))
      SIG(4)=SQRT(TRA(4,4))
      SIG(5)=SQRT(TRA(1,1)+TRA(2,2)+TRA(3,3))
      SIG(6)=SQRT(TRA(1,1)+TRA(2,2)+TRA(3,3)+TRA(4,4))
      RETURN
   35 SIG(1)=1000.
      SIG(2)=1000.
      SIG(3)=1000.
      SIG(4)=1000.
      SIG(5)=1000.
      SIG(6)=1000.
      RETURN
      END

*****************************************************************
*****************************************************************
```

```
************************************************************************
************************************************************************
      BLOCK DATA
      COMMON/CON/C(18)
      DATA C/.01745329252,57.295779513,3.1415926536,6.28318530718,
     11.57079630,6076.116,0.,0.,0.,2.0926143504E+07,
     27.29211585E-05,1.4076380E+16,365.2563835 ,92.91
     3E+06,0.0167272,23.44436,-77.7303,5280./
      END
************************************************************************
************************************************************************
      SUBROUTINE VECTOR(V1,I,V2,V3)
      DIMENSION V1(3),V2(3),V3(3)
      GO TO (10,15,20),I
   10 V3(1)=V1(1)+V2(1)
      V3(2)=V1(2)+V2(2)
      V3(3)=V1(3)+V2(3)
      RETURN
   15 V3(1)=V1(1)-V2(1)
      V3(2)=V1(2)-V2(2)
      V3(3)=V1(3)-V2(3)
      RETURN
   20 V3(1)=V1(2)*V2(3)-V1(3)*V2(2)
      V3(2)=V1(3)*V2(1)-V1(1)*V2(3)
      V3(3)=V1(1)*V2(2)-V1(2)*V2(1)
      RETURN
      END
************************************************************************
************************************************************************
      FUNCTION DOT(V1,V2)
      DIMENSION V1(3),V2(3)
      DOT=V1(1)*V2(1)+V1(2)*V2(2)+V1(3)*V2(3)
      RETURN
      END
************************************************************************
************************************************************************
      SUBROUTINE UNIVEC (V,UV)
      DIMENSION V(3),UV(3)
      DENOM = SQRT(DOT(V,V))
      UV(1) = V(1)/DENOM
      UV(2) = V(2)/DENOM
      UV(3) = V(3)/DENOM
      RETURN
      END
************************************************************************
************************************************************************
      SUBROUTINE TALL (MAX,MXX,MATRIX)
      DIMENSION MATRIX(10626,4)
      DO 10 I=1,10626
      DO 10 II=1,4
   10 MATRIX(I,II)=0
      IF(MAX.LT.3) GO TO 35
      MXX=(MAX-3)*(MAX-2)*(MAX-1)*MAX/24
      KK=MAX-3
      LL=MAX-2
      MM=MAX-1
      NN=MAX
```

```
      NA=0
      DO 30 K=1,KK
      KO=K+1
      DO 25 L=KO,LL
      KT=L+1
      DO 20 M=KT,MM
      KP=M+1
      DO 15 N=KP,NN
      NA=NA+1
      MATRIX(NA,1)=K
      MATRIX(NA,2)=L
      MATRIX(NA,3)=M
      MATRIX(NA,4)=N
 15   CONTINUE
 20   CONTINUE
 25   CONTINUE
 30   CONTINUE
 35   RETURN
      END
******************************************************************
******************************************************************
**          THIS SUBROUTINE ALLOWS THE USER TO SELECTIVELY           **
**      DELETE UP TO TEN SATELLITES FROM THE NOMINAL CONSTEL-        **
**      LATION. 'NDEL' IS THE NUMBER OF SATELLITES TO BE DELETED     **
**      AND IS ENTERED AS THE LAST ITEM ON THE FIRST LINE OF         **
**      DATA INPUT.  WHEN SATELLITES ARE TO BE DELETED, THE NEXT     **
**      LINE OF DATA SHOULD CONTAIN THE IDENTIFICATION NUMBERS       **
**      OF THE SATELLITES TO BE DELETED FROM THE CONSTELLATION       **
**      ENTERED IN DESCENDING ORDER (HIGHEST ID NUMBER TO LOWEST).   **
**      'JDEL(I)' CONTAINS THE ID NUMBERS OF THESE SATELLITES.       **
******************************************************************
******************************************************************
      SUBROUTINE SATDEL(P,PER,NJL,NDEL,JDEL)
      DIMENSION P(37,25),PER(36),JDEL(10)
      DO 40 J=1,NDEL
      NJL=NJL-1
      DO 20 N=JDEL(J),NJL
      M=N+1
      DO 10 K=1,5
      P(N,K)=P(M,K)
      PER(N)=PER(M)
 10   CONTINUE
 20   CONTINUE
      DO 25 L=1,5
 25   P(M,L)=0
      PER(M)=0
 40   CONTINUE
      RETURN
      END
```

Appendix D
Samples of Computer Output

This section of the appendix contains a sample of the computer program output for each of the two types of runs utilized in this analysis. Table XX provides the complete output obtained for a representative global distribution run in which a network of earth-based users are uniformly distributed over the surface of the earth. Table XXI contains the complete output listing representing the case in which the user is situated on a satellite (space-based user). No sample output is provided for the case of a single user at a specific location on the earth (Case 2), as this portion of the program was not used in this analysis.

TABLE XX
Sample Output - Global Distribution Run

```
                 ORBITAL ELEMENTS

        ECC     ARGP     RASC     INC      ANOM     PER

  1     .05   224.50    30.00   55.00     0.00   12.00
  2     .05   224.50    30.00   55.00   125.00   12.00
  3     .05   224.50    30.00   55.00   235.00   12.00
  4     .05   224.50    90.00   55.00    42.00   12.00
  5     .05   224.50    90.00   55.00   160.30   12.00
  6     .05   224.50    90.00   55.00   272.30   12.00
  7     .05   224.50   150.00   55.00    83.00   12.00
  8     .05   224.50   150.00   55.00   195.80   12.00
  9     .05   224.50   150.00   55.00   313.30   12.00
 10     .05   224.50   210.00   55.00   122.30   12.00
 11     .05   224.50   210.00   55.00   232.60   12.00
 12     .05   224.50   210.00   55.00   357.00   12.00
 13     .05   224.50   270.00   55.00   161.00   12.00
 14     .05   224.50   270.00   55.00   273.30   12.00
 15     .05   224.50   270.00   55.00    42.80   12.00
 16     .05   224.50   330.00   55.00   199.00   12.00
 17     .05   224.50   330.00   55.00    86.70   12.00
 18     .05   224.50   330.00   55.00   317.20   12.00

GLOBAL DISTRIBUTION CALCULATIONS

MASKING ANGLE =   5.00 DEGREES
LATITUDE STEP =   5.00 DEGREES
LATITUDE INCREMENT =   2
LONGITUDE INCREMENT =   2
DILUTION OF PRECISION PARAMETERS PRINTED AT TIME INCREMENT OF     0

TOTAL TIME(MIN) =   240
TIME INCREMENT(MIN) =   5

THE SATELLITE MOST NEARLY OVERHEAD IS USED AS ONE OF THE FOUR
IN ALL CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON
```

TABLE XX (Continued)

ELEVATION DISTRIBUTION - PROBABILITY THAT THE SATELLITE IN VIEW WILL HAVE ELEVATION ANGLES AS LISTED

ELEVATION ANGLE

	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90
PROB	0.0	10.7	10.7	9.7	10.1	9.3	8.9	8.0	8.0	6.7	4.5	4.1	2.6	2.6	1.9	1.3	.9	.2

LATITUDE ELEVATION DISTRIBUTION
PROBABILITY THAT ANY SATELLITE IN VIEW WILL HAVE AN ELEVATION ANGLE GREATER THAN OR EQUAL TO THOSE LISTED

LATITUDE

ELEV ANGLE	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00
5	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00
10	.91	0.00	.91	0.00	.90	0.00	.88	0.00	.88	0.00	.90	0.00	.90	0.00	.88	0.00	.88	0.00	.89
15	.82	0.00	.82	0.00	.80	0.00	.74	0.00	.77	0.00	.80	0.00	.80	0.00	.78	0.00	.75	0.00	.77
20	.73	0.00	.72	0.00	.69	0.00	.63	0.00	.68	0.00	.70	0.00	.71	0.00	.69	0.00	.67	0.00	.67
25	.63	0.00	.62	0.00	.55	0.00	.54	0.00	.59	0.00	.62	0.00	.62	0.00	.61	0.00	.57	0.00	.53
30	.54	0.00	.51	0.00	.45	0.00	.46	0.00	.51	0.00	.54	0.00	.54	0.00	.52	0.00	.47	0.00	.41
35	.43	0.00	.37	0.00	.36	0.00	.39	0.00	.44	0.00	.47	0.00	.47	0.00	.45	0.00	.36	0.00	.34
40	.30	0.00	.26	0.00	.29	0.00	.32	0.00	.38	0.00	.41	0.00	.40	0.00	.37	0.00	.30	0.00	.27
45	.10	0.00	.17	0.00	.23	0.00	.27	0.00	.32	0.00	.34	0.00	.34	0.00	.29	0.00	.23	0.00	.21
50	0.00	0.00	.10	0.00	.17	0.00	.22	0.00	.26	0.00	.28	0.00	.27	0.00	.21	0.00	.17	0.00	.16
55	0.00	0.00	.03	0.00	.12	0.00	.17	0.00	.22	0.00	.23	0.00	.21	0.00	.16	0.00	.13	0.00	.12
60	0.00	0.00	0.00	0.00	.07	0.00	.13	0.00	.17	0.00	.18	0.00	.14	0.00	.10	0.00	.09	0.00	.09
65	0.00	0.00	0.00	0.00	.03	0.00	.09	0.00	.13	0.00	.14	0.00	.10	0.00	.08	0.00	.07	0.00	.06
70	0.00	0.00	0.00	0.00	.00	0.00	.06	0.00	.09	0.00	.09	0.00	.06	0.00	.05	0.00	.04	0.00	.04
75	0.00	0.00	0.00	0.00	0.00	0.00	.03	0.00	.06	0.00	.05	0.00	.03	0.00	.02	0.00	.02	0.00	.02
80	0.00	0.00	0.00	0.00	0.00	0.00	.01	0.00	.04	0.00	.02	0.00	.01	0.00	.01	0.00	.01	0.00	.01
85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.01	0.00	.00	0.00	.00	0.00	0.00	0.00	.00	0.00	.00

ACCUMULATIVE ELEVATION DISTRIBUTION
PROBABILITY THAT THE ELEVATION ANGLE IS GREATER THAN OR EQUAL TO THOSE LISTED

ELEVATION ANGLE

	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
PROB	1.0	1.0	.9	.8	.7	.6	.5	.4	.3	.3	.2	.2	.1	.1	.1	.0	.0	.0

TABLE XX (Continued)

DILUTION OF PRECISION - ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT ALTITUDE DOP WILL BE GREATER THAN NUMBER LISTED

LATITUDE

NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.4	1.000	0.000	1.000	0.000	1.000	0.000	.994	0.000	1.000	0.000	.994	0.000	.999	0.000	.998	0.000	1.000	0.000	1.000
1.6	1.000	0.000	1.000	0.000	1.000	0.000	.857	0.000	.838	0.000	.870	0.000	.960	0.000	.973	0.000	.981	0.000	952
1.8	1.000	0.000	1.000	0.000	.834	0.000	.522	0.000	.667	0.000	.761	0.000	.872	0.000	.827	0.000	846	0.000	873
2.0	.898	0.000	.924	0.000	.601	0.000	.397	0.000	.449	0.000	.628	0.000	.649	0.000	.565	0.000	.556	0.000	545
2.2	.694	0.000	.582	0.000	.498	0.000	.325	0.000	.270	0.000	.427	0.000	.492	0.000	.382	0.000	.350	0.000	.330
2.4	.449	0.000	.218	0.000	.415	0.000	.285	0.000	.156	0.000	.271	0.000	.367	0.000	.257	0.000	.222	0.000	.155
2.6	.408	0.000	.122	0.000	.395	0.000	.249	0.000	.115	0.000	.138	0.000	.202	0.000	.160	0.000	.155	0.000	076
2.8	.408	0.000	.122	0.000	.346	0.000	.234	0.000	.087	0.000	.077	0.000	.110	0.000	.117	0.000	.126	0.000	.041
3.0	.408	0.000	.122	0.000	.296	0.000	.209	0.000	.078	0.000	.066	0.000	.075	0.000	.094	0.000	.107	0.000	034
3.2	.347	0.000	.118	0.000	.238	0.000	.169	0.000	.067	0.000	.049	0.000	.048	0.000	.065	0.000	.090	0.000	.032
3.4	.265	0.000	.098	0.000	.196	0.000	130	0.000	.059	0.000	.043	0.000	.029	0.000	.039	0.000	.067	0.000	.032
3.6	.204	0.000	.078	0.000	.160	0.000	.099	0.000	.050	0.000	.037	0.000	.022	0.000	.028	0.000	.046	0.000	.032
3.8	.122	0.000	.063	0.000	.116	0.000	.063	0.000	.042	0.000	.029	0.000	.012	0.000	.018	0.000	.036	0.000	.029
4.0	.061	0.000	.044	0.000	.084	0.000	.041	0.000	.035	0.000	.020	0.000	.003	0.000	.010	0.000	.028	0.000	.025
4.2	.041	0.000	.029	0.000	.046	0.000	.027	0.000	.026	0.000	.017	0.000	0.000	0.000	.008	0.000	019	0.000	.017
4.4	.020	0.000	.011	0.000	.020	0.000	.015	0.000	.022	0.000	.014	0.000	0.000	0.000	.006	0.000	.007	0.000	012
4.6	0.000	0.000	.009	0.000	.012	0.000	.008	0.000	.016	0.000	.012	0.000	0.000	0.000	.003	0.000	.006	0.000	008
4.8	0.000	0.000	.003	0.000	.008	0.000	.003	0.000	.009	0.000	.010	0.000	0.000	0.000	.001	0.000	.005	0.000	.007
5.0	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	.007	0.000	.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.001
5.2	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	.005	0.000	.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.4	0.000	0.000	0.000	0.000	0.000	0.000	.001	0.000	.002	0.000	.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.001	0.000	.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE XX (Continued)

DILUTION OF PRECISION - ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT POSITION DOP IN HORIZONTAL PLANE WILL BE GREATER THAN NUMBER LISTED

	LATITUDE																		
NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.2	.959	0.000	.994	0.000	.955	0.000	.961	0.000	.958	0.000	.999	0.000	.998	0.000	.998	0.000	.978	0.000	.999
1.4	.306	0.000	.182	0.000	.512	0.000	.574	0.000	.773	0.000	.827	0.000	.737	0.000	.658	0.000	.518	0.000	.489
1.6	061	0.000	.043	0.000	.243	0.000	.371	0.000	.416	0.000	.424	0.000	.434	0.000	.249	0.000	.153	0.000	.104
1.8	0.000	0.000	.006	0.000	.145	0.000	.167	0.000	.194	0.000	.162	0.000	.196	0.000	.062	0.000	.050	0.000	.034
2.0	0.000	0.000	0.000	0.000	.051	0.000	.058	0.000	.083	0.000	.060	0.000	.050	0.000	.020	0.000	.011	0.000	.032
2.2	0.000	0.000	0.000	0.000	.015	0.000	.026	0.000	.044	0.000	.032	0.000	.016	0.000	.009	0.000	.001	0.000	.016
2.4	0.000	0.000	0.000	0.000	.003	0.000	.009	0.000	.028	0.000	.015	0.000	.001	0.000	.002	0.000	0.000	0.000	.008
2.6	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	.020	0.000	.009	0.000	.001	0.000	.001	0.000	0.000	0.000	.002
2.8	0.000	0.000	0.000	0.000	0.000	0.000	.001	0.000	.012	0.000	.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.006	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE XX (Continued)

DILUTION OF PRECISION - ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT LARGER COMPONENT OF POSITION DOP WILL BE GREATER THAN NUMBER LISTED

LATITUDE

NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.0	.732	0.000	.414	0.000	.650	0.000	.732	0.000	.898	0.000	.892	0.000	.951	0.000	.850	0.000	.803	0.000	.863
1.2	.163	0.000	.108	0.000	.356	0.000	.388	0.000	.516	0.000	.813	0.000	.557	0.000	.392	0.000	.269	0.000	.213
1.4	.036	0.000	.025	0.000	.178	0.000	.166	0.000	.257	0.000	.219	0.000	.224	0.000	.125	0.000	.103	0.000	.050
1.6	0.000	0.000	.006	0.000	.070	0.000	.057	0.000	.111	0.000	.085	0.000	.079	0.000	034	0.000	.023	0.000	.028
1.8	0.000	0.000	0.000	0.000	.012	0.000	.019	0.000	.058	0.000	.051	0.000	.034	0.000	.015	0.000	.003	0.000	010
2.0	0.000	0.000	0.000	0.000	.006	0.000	.008	0.000	.036	0.000	.033	0.000	.011	0.000	.005	0.000	0.000	0.000	0.000
2.2	0.000	0.000	0.000	0.000	.002	0.000	.002	0.000	.024	0.000	.016	0.000	.002	0.000	.001	0.000	0.000	0.000	0.000
2.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.019	0.000	.009	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000
2.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.014	0.000	.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.006	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE XX (Continued)

DILUTION OF PRECISION - ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT TIME DOP WILL BE GREATER THAN NUMBER LISTED

LATITUDE

NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.8	1.000	0.000	1.000	0.000	1.000	0.000	.944	0.000	.927	0.000	.968	0.000	.964	0.000	.969	0.000	.906	0.000	.961
1.0	.735	0.000	.956	0.000	.752	0.000	.584	0.000	.755	0.000	.772	0.000	.799	0.000	.677	0.000	.694	0.000	.749
1.2	.571	0.000	.363	0.000	.512	0.000	.418	0.000	.473	0.000	.573	0.000	.524	0.000	.431	0.000	.366	0.000	.349
1.4	.408	0.000	.122	0.000	.389	0.000	.321	0.000	.193	0.000	.322	0.000	.381	0.000	.263	0.000	.203	0.000	.075
1.6	.408	0.000	.122	0.000	.368	0.000	.264	0.000	.129	0.000	.172	0.000	.265	0.000	.179	0.000	.146	0.000	.036
1.8	.347	0.000	.118	0.000	.320	0.000	.227	0.000	.101	0.000	.084	0.000	.180	0.000	.125	0.000	.118	0.000	.034
2.0	.245	0.000	.099	0.000	.257	0.000	.190	0.000	.078	0.000	.060	0.000	.098	0.000	.078	0.000	.096	0.000	.032
2.2	.163	0.000	.073	0.000	.200	0.000	.144	0.000	.063	0.000	.048	0.000	.037	0.000	.034	0.000	.062	0.000	.032
2.4	.061	0.000	.050	0.000	.139	0.000	.093	0.000	.052	0.000	.043	0.000	.016	0.000	.020	0.000	.043	0.000	.029
2.6	.041	0.000	.035	0.000	.080	0.000	.056	0.000	.043	0.000	.035	0.000	.005	0.000	.015	0.000	.019	0.000	.027
2.8	0.000	0.000	.011	0.000	.035	0.000	.025	0.000	.033	0.000	.023	0.000	0.000	0.000	.015	0.000	.012	0.000	.023
3.0	0.000	0.000	.008	0.000	.012	0.000	.008	0.000	.023	0.000	.019	0.000	0.000	0.000	.014	0.000	.007	0.000	.012
3.2	0.000	0.000	.001	0.000	0.000	0.000	.003	0.000	.016	0.000	.017	0.000	0.000	0.000	.009	0.000	0.000	0.000	.002
3.4	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	.010	0.000	.014	0.000	0.000	0.000	.007	0.000	0.000	0.000	0.000
3.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.005	0.000	.011	0.000	0.000	0.000	.005	0.000	0.000	0.000	0.000
3.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000
4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE XX (Continued)

DILUTION OF PRECISION · ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT THREE DIMENSIONAL POSITION DOP WILL BE GREATER THAN NUMBER LISTED

LATITUDE

NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
2.0	1.000	0.000	1.000	0.000	1.000	0.000	.933	0.000	.937	0.000	.974	0.000	.988	0.000	.993	0.000	.984	0.000	.992
2.2	1.000	0.000	1.000	0.000	.847	0.000	.664	0.000	.819	0.000	.850	0.000	.909	0.000	.910	0.000	.913	0.000	.938
2.4	.959	0.000	.870	0.000	.663	0.000	.501	0.000	.662	0.000	.729	0.000	.802	0.000	.676	0.000	.586	0.000	.612
2.6	.673	0.000	.474	0.000	.560	0.000	.378	0.000	.382	0.000	.600	0.000	.600	0.000	.458	0.000	.410	0.000	.375
2.8	.429	0.000	.171	0.000	.427	0.000	.308	0.000	.228	0.000	.365	0.000	.392	0.000	.293	0.000	.257	0.000	.154
3.0	.408	0.000	.122	0.000	.396	0.000	.261	0.000	.138	0.000	.198	0.000	.277	0.000	.189	0.000	.171	0.000	.065
3.2	.408	0.000	.122	0.000	.346	0.000	.238	0.000	.105	0.000	.088	0.000	.176	0.000	.128	0.000	.126	0.000	.041
3.4	.347	0.000	.119	0.000	.286	0.000	.211	0.000	.090	0.000	.070	0.000	.100	0.000	.095	0.000	.105	0.000	.034
3.6	.306	0.000	.107	0.000	.238	0.000	.179	0.000	.077	0.000	.058	0.000	.063	0.000	.060	0.000	.084	0.000	.034
3.8	.245	0.000	.098	0.000	.197	0.000	.142	0.000	.065	0.000	.043	0.000	.032	0.000	.039	0.000	.063	0.000	.032
4.0	.143	0.000	.074	0.000	.152	0.000	.110	0.000	.056	0.000	.041	0.000	.023	0.000	.027	0.000	.043	0.000	.032
4.2	.082	0.000	.051	0.000	.110	0.000	.070	0.000	.048	0.000	.035	0.000	.011	0.000	.017	0.000	.032	0.000	.032
4.4	.041	0.000	.039	0.000	.073	0.000	.046	0.000	.041	0.000	.026	0.000	.003	0.000	.012	0.000	.028	0.000	.028
4.6	.020	0.000	.023	0.000	.044	0.000	.029	0.000	.035	0.000	.020	0.000	.001	0.000	.009	0.000	.016	0.000	.023
4.8	0.000	0.000	.011	0.000	.023	0.000	.012	0.000	.029	0.000	.016	0.000	0.000	0.000	.007	0.000	.011	0.000	.018
5.0	0.000	0.000	.008	0.000	.009	0.000	.008	0.000	.022	0.000	.014	0.000	0.000	0.000	.005	0.000	.008	0.000	.011
5.2	0.000	0.000	0.000	0.000	.002	0.000	.005	0.000	.018	0.000	.011	0.000	0.000	0.000	.002	0.000	.005	0.000	.009
5.4	0.000	0.000	0.000	0.000	.002	0.000	.003	0.000	.015	0.000	.009	0.000	0.000	0.000	.001	0.000	0.000	0.000	.005
5.6	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	.011	0.000	.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.8	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	.005	0.000	.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.0	0.000	0.000	0.000	0.000	0.000	0.000	.001	0.000	.003	0.000	.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.001	0.000	.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE XX (Continued)

DILUTION OF PRECISION - ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT FOUR DIMENSIONAL POSITION DOP WILL BE GREATER THAN NUMBER LISTED

LATITUDE

NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
2.0	1.000	0.000	1.000	0.000	1.000	0.000	.997	0.000	.994	0.000	.997	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
2.2	1.000	0.000	1.000	0.000	1.000	0.000	.902	0.000	.929	0.000	.964	0.000	.976	0.000	.984	0.000	.974	0.000	.983
2.4	1.000	0.000	1.000	0.000	.847	0.000	.666	0.000	.799	0.000	.839	0.000	.906	0.000	.881	0.000	.875	0.000	.927
2.6	.918	0.000	.897	0.000	.675	0.000	.514	0.000	.684	0.000	.740	0.000	.803	0.000	.667	0.000	.600	0.000	.603
2.8	.694	0.000	.576	0.000	.585	0.000	.415	0.000	.468	0.000	.646	0.000	.642	0.000	.503	0.000	.461	0.000	.429
3.0	.510	0.000	.232	0.000	.463	0.000	.339	0.000	.283	0.000	.469	0.000	.486	0.000	.358	0.000	.295	0.000	.218
3.2	.408	0.000	.122	0.000	.408	0.000	.298	0.000	.190	0.000	.304	0.000	.349	0.000	.249	0.000	.200	0.000	.037
3.4	.408	0.000	.122	0.000	.387	0.000	.263	0.000	.135	0.000	.184	0.000	.276	0.000	.181	0.000	.155	0.000	.052
3.6	.408	0.000	.122	0.000	.346	0.000	.241	0.000	.109	0.000	.094	0.000	.198	0.000	.141	0.000	.126	0.000	.040
3.8	.367	0.000	.120	0.000	.304	0.000	.220	0.000	.094	0.000	.070	0.000	.139	0.000	.107	0.000	.115	0.000	.034
4.0	.347	0.000	.118	0.000	.265	0.000	.201	0.000	.082	0.000	.062	0.000	.090	0.000	.082	0.000	.101	0.000	.034
4.2	.245	0.000	.099	0.000	.228	0.000	.167	0.000	.070	0.000	.053	0.000	.059	0.000	.051	0.000	.082	0.000	.032
4.4	.204	0.000	.090	0.000	.197	0.000	.143	0.000	.062	0.000	.044	0.000	.033	0.000	.033	0.000	.065	0.000	.032
4.6	.122	0.000	.070	0.000	.163	0.000	.117	0.000	.057	0.000	.043	0.000	.022	0.000	.026	0.000	.045	0.000	.032
4.8	.082	0.000	.058	0.000	.126	0.000	.084	0.000	.050	0.000	.036	0.000	.014	0.000	.019	0.000	.033	0.000	.032
5.0	.061	0.000	.044	0.000	.094	0.000	.060	0.000	.045	0.000	.035	0.000	.008	0.000	.016	0.000	.029	0.000	.029
5.2	.041	0.000	.032	0.000	.060	0.000	.040	0.000	.041	0.000	.026	0.000	.001	0.000	.014	0.000	.018	0.000	.025
5.4	0.000	0.000	.020	0.000	.039	0.000	.027	0.000	.036	0.000	.022	0.000	0.000	0.000	.012	0.000	.014	0.000	.023
5.6	0.000	0.000	.010	0.000	.022	0.000	.014	0.000	.029	0.000	.018	0.000	0.000	0.000	.009	0.000	.010	0.000	.019
5.8	0.000	0.000	.007	0.000	.014	0.000	.007	0.000	.024	0.000	.016	0.000	0.000	0.000	.008	0.000	.006	0.000	.014
6.0	0.000	0.000	.001	0.000	.005	0.000	.005	0.000	.019	0.000	.014	0.000	0.000	0.000	.005	0.000	.005	0.000	.008
6.2	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	.017	0.000	.012	0.000	0.000	0.000	.003	0.000	0.000	0.000	.005
6.4	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	.014	0.000	.010	0.000	0.000	0.000	.002	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	.010	0.000	.009	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000
6.8	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	.003	0.000	.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0	0.000	0.000	0.000	0.000	0.000	0.000	.001	0.000	.003	0.000	.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE XX (Continued)

DILUTION OF PRECISION PARAMETERS - ACCUMULATIVE GLOBAL DISTRIBUTION

NUMBER	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP
0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.8	1.0000	1.0000	1.0000	.9533	1.0000	1.0000
1.0	1.0000	1.0000	.8362	.7326	1.0000	1.0000
1.2	1.0000	.9855	.3965	.4438	1.0000	1.0000
1.4	.9983	.6244	.1519	.2473	1.0000	1.0000
1.6	.9353	.2789	.0549	.1726	1.0000	1.0000
1.8	.7995	.1117	.0237	.1280	1.0000	1.0000
2.0	.5662	.0404	.0110	.0935	.9783	.9987
2.2	.3853	.0177	.0052	.0624	.8773	.9677
2.4	.2517	.0074	.0033	.0441	.6647	.8815
2.6	.1632	.0042	.0020	.0290	.4660	.6702
2.8	.1193	.0019	.0007	.0183	.2862	.5174
3.0	.0997	.0007	.0005	.0114	.1896	.3501
3.2	.0786	.0005	.0001	.0058	.1338	.2391
3.4	.0611	.0001	0.0000	.0039	.1044	.1813
3.6	.0485	0.0000	0.0000	.0026	.0823	.1400
3.8	.0362	0.0000	0.0000	.0013	.0624	.1153
4.0	.0258	0.0000	0.0000	.0007	.0493	.0965
4.2	.0174	0.0000	0.0000	.0004	.0367	.0765
4.4	.0105	0.0000	0.0000	.0004	.0277	.0617
4.6	.0074	0.0000	0.0000	.0003	.0193	.0508
4.8	.0050	0.0000	0.0000	.0003	.0133	.0401
5.0	.0021	0.0000	0.0000	.0003	.0084	.0332
5.2	.0014	0.0000	0.0000	.0001	.0063	.0239
5.4	.0007	0.0000	0.0000	0.0000	.0039	.0190
5.6	.0005	0.0000	0.0000	0.0000	.0025	.0139
5.8	.0004	0.0000	0.0000	0.0000	.0014	.0102
6.0	.0003	0.0000	0.0000	0.0000	.0009	.0070
6.2	.0003	0.0000	0.0000	0.0000	.0005	.0048
6.4	.0003	0.0000	0.0000	0.0000	.0003	.0032
6.6	.0001	0.0000	0.0000	0.0000	.0003	.0025
6.8	0.0000	0.0000	0.0000	0.0000	.0003	.0015
7.0	0.0000	0.0000	0.0000	0.0000	.0003	.0011

TABLE XX (Continued)

MAXIMUM AND MINIMUM NUMBERS SEEN AT EACH LATITUDE & LONGITUDE

MAXIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0
85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80.	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0
75.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0
65.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60.	9	0	8	0	8	0	8	0	9	0	8	0	8	0	8	0	9	0	9	0	8	0	8	0	8	0	9	0	8	0	8	0	8	0	9	0
55.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	7	0	7	0	8	0	7	0	7	0	7	0	8	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0
45.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.	7	0	7	0	7	0	8	0	7	0	6	0	7	0	8	0	8	0	7	0	7	0	7	0	8	0	7	0	7	0	7	0	8	0	8	0
35.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	7	0	7	0	7	0	8	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0	7	0	8	0	7	0	7	0	7	0	8	0	8	0
25.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.	8	0	8	0	7	0	7	0	7	0	8	0	7	0	7	0	7	0	8	0	8	0	8	0	7	0	8	0	8	0	7	0	7	0	7	0
15.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	8	0	8	0	7	0	7	0	7	0	8	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0	8	0	8	0	7	0	7	0	7	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.	8	0	8	0	7	0	7	0	7	0	8	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0	8	0	8	0	8	0	7	0	7	0

MINIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0
85.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80.	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0
75.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0
65.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60.	5	0	6	0	5	0	5	0	5	0	6	0	5	0	5	0	5	0	5	0	6	0	5	0	5	0	5	0	6	0	5	0	5	0	5	0
55.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
45.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.	4	0	4	0	5	0	5	0	5	0	4	0	5	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0	5	0
35.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
25.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	5	0	5	0	5	0	4	0	4	0	5	0	5	0	5	0	4	0	5	0	5	0	5	0	4	0	4	0	5	0	5	0	5	0	4	0
15.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	6	0	6	0	5	0	5	0	6	0	6	0	5	0	5	0	6	0	5	0	6	0	5	0	5	0	5	0	6	0	5	0	5	0	5	0
5.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.	6	0	6	0	6	0	5	0	6	0	6	0	6	0	5	0	5	0	6	0	6	0	6	0	5	0	6	0	6	0	6	0	5	0	5	0

TABLE XX (Continued)

NUMBER OF SATELLITES

LAT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PROBABILITY (IN PERCENT) OF SEEING EXACTLY N SATELLITES																
90.	0.00	0.00	0.00	0.00	0.00	0.00	40.82	10.20	48.98	0.00						
85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
80.	0.00	0.00	0.00	0.00	0.00	0.00	12.24	70.41	17.35	0.00						
75.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
70.	0.00	0.00	0.00	0.00	0.00	0.00	37.64	32.09	30.27	0.00						
65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
60.	0.00	0.00	0.00	0.00	0.00	11.56	30.61	35.37	21.66	.79						
55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
50	0.00	0.00	0.00	0.00	0.00	12.70	65.31	21.77	.23	0.00						
45.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
40.	0.00	0.00	0.00	0.00	1.93	25.08	60.20	8.50	4.31	0.00						
35.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
30.	0.00	0.00	0.00	0.00	0.00	30.95	50.68	16.33	2.04	0.00						
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
20	0.00	0.00	0.00	0.00	1.47	16.21	55.90	23.36	3.06	0.00						
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
10.	0.00	0.00	0.00	0.00	0.00	14.51	34.81	42.18	8.50	0.00						
5.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
0.	0.00	0.00	0.00	0.00	0.00	3.51	42.63	50.34	3.51	0.00						
PROBABILITY (IN PERCENT) OF SEEING N OR MORE SATELLITES																
90.	100.00	100.00	100.00	100.00	100.00	100.00	100.00	59.18	48.98	0.00						
85.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
80.	100.00	100.00	100.00	100.00	100.00	100.00	100.00	87.76	17.35	0.00						
75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
70.	100.00	100.00	100.00	100.00	100.00	100.00	100.00	62.36	30.27	0.00						
65.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
60.	100.00	100.00	100.00	100.00	100.00	100.00	88.44	57.82	22.45	.79						
55.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
50.	100.00	100.00	100.00	100.00	100.00	100.00	87.30	22.00	.23	0.00						
45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
40.	100.00	100.00	100.00	100.00	100.00	98.07	73.02	12.81	4.31	0.00						
35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
30.	100.00	100.00	100.00	100.00	100.00	100.00	69.05	18.37	2.04	0.00						
25.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
20	100.00	100.00	100.00	100.00	100.00	98.53	82.31	26.42	3.06	0.00						
15.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
10	100.00	100.00	100.00	100.00	100.00	100.00	85.49	50.68	8.50	0.00						
5.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
0.	100.00	100.00	100.00	100.00	100.00	100.00	96.49	53.85	3.51	0.00						
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT EXACTLY N SATELLITES WILL BE SEEN																
PROB	0.00	0.00	0.00	0.00	.46	14.98	46.94	30.47	7.11	.06						
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT N OR MORE SATELLITES WILL BE SEEN																
PROB	100.00	100.00	100.00	100.00	100.00	99.54	84.58	37.64	7.17	.06						

TABLE XXI
Sample Output - Satellite User

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
1	.000	.00	30.00	55.00	.00	12.00
2	.000	.00	30.00	55.00	120.00	12.00
3	.000	.00	30.00	55.00	240.00	12.00
4	.000	.00	90.00	55.00	40.00	12.00
5	.000	.00	90.00	55.00	160.00	12.00
6	.000	.00	90.00	55.00	280.00	12.00
7	.000	.00	150.00	55.00	80.00	12.00
8	.000	.00	150.00	55.00	200.00	12.00
9	.000	.00	150.00	55.00	320.00	12.00
10	.000	.00	210.00	55.00	120.00	12.00
11	.000	.00	210.00	55.00	240.00	12.00
12	.000	.00	210.00	55.00	360.00	12.00
13	.000	.00	270.00	55.00	160.00	12.00
14	.000	.00	270.00	55.00	280.00	12.00
15	.000	.00	270.00	55.00	40.00	12.00
16	.000	.00	330.00	55.00	200.00	12.00
17	.000	.00	330.00	55.00	320.00	12.00
18	.000	.00	330.00	55.00	80.00	12.00

USER SATELLITE ORBITAL ELEMENTS

19	.999	.00	.00	45.00	178.50	.92

TOTAL TIME(MIN) = 59
TIME INCREMENT(MIN) = 1
BEAMWIDTH ANGLE(DEG) = 21.40
FRACTION OF NAVSAT SPHERICAL AREA = 1.000

ALL SATELLITES, TAKEN FOUR AT A TIME, ARE USED IN
THE CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON

TABLE XXI (Continued)

TIME(MN)	ALT(NM)	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP	SATELLITES CHOSEN
0	404.	1.095	1.159	.835	.520	1.595	1.677	16 3 7 13 2 4 5 9 11 12 14
1	587.	1.093	1.157	.832	.517	1.592	1.673	16 3 7 13 2 4 5 9 11 12 14
2	720.	1.092	1.155	.830	.513	1.589	1.670	16 3 7 13 2 4 5 9 11 12 14
3	859.	1.091	1.154	.828	.511	1.588	1.668	16 3 7 13 2 4 5 9 11 12 14 15
4	984.	1.091	1.153	.827	.508	1.587	1.666	16 3 7 13 2 4 5 9 11 12 14 15 18
5	1099.	1.091	1.152	.826	.506	1.587	1.666	16 3 7 13 2 4 5 9 11 12 14 15 18
6	1203.	1.091	1.152	.825	.505	1.587	1.666	16 3 7 13 2 4 5 9 11 12 14 15 18
7	1296.	1.092	1.152	.824	.504	1.588	1.666	16 3 7 13 2 4 5 9 11 12 14 15 18
8	1380.	1.094	1.153	.824	.503	1.589	1.667	16 3 7 13 2 4 5 9 11 12 14 15 18
9	1454.	1.095	1.153	.824	.502	1.590	1.668	16 3 7 13 2 4 5 9 11 12 14 15 18
10	1518.	1.097	1.154	.824	.502	1.592	1.669	16 3 7 13 2 4 5 9 11 12 14 15 18
11	1573.	1.099	1.154	.824	.502	1.594	1.671	16 3 7 13 2 4 5 9 11 12 14 15 18
12	1620.	1.101	1.155	.824	.502	1.596	1.673	16 3 7 13 2 4 5 9 11 12 14 15 18
13	1658.	.940	1.249	.947	.512	1.563	1.645	16 4 5 6 2 3 7 9 11 12 13 14 15 18
14	1686.	.941	1.246	.942	.512	1.561	1.643	16 4 5 6 2 3 7 9 11 12 13 14 15 18
15	1706.	.941	1.243	.937	.513	1.560	1.642	16 4 5 6 2 3 7 9 11 12 13 14 15 18
16	1717.	.942	1.241	.932	.513	1.558	1.640	16 4 5 6 2 3 7 9 11 12 13 14 15 18
17	1721.	.943	1.238	.927	.513	1.556	1.639	16 4 5 6 2 3 7 9 11 12 13 14 15 18
18	1715.	.943	1.236	.922	.513	1.555	1.637	16 4 5 6 2 3 7 9 11 12 13 14 15 18
19	1701.	.944	1.233	.918	.513	1.553	1.638	16 4 5 6 2 3 7 9 11 12 13 14 15 18

TABLE XXI (Continued)

TIME (MN)	ALT (NM)	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP	SATELLITES CHOSEN
20	1679	.944	1.231	.914	.513	1.552	1.634	16 4 5 6 2 3 7 9 11 12 13 14 15 18
21	1648	.945	1.229	.909	.513	1.550	1.633	16 4 5 6 2 3 7 9 11 12 13 14 15 18
22	1609	.945	1.227	.906	.513	1.549	1.631	16 4 5 6 2 3 7 9 11 12 13 14 15 18
23	1560	.945	1.225	.902	.513	1.547	1.630	16 4 5 6 2 3 7 9 11 12 13 14 15 18
24	1502	.946	1.223	.898	.512	1.546	1.628	16 4 5 6 2 3 7 9 11 12 13 14 15 18
25	1436	1.010	1.196	.892	.515	1.566	1.648	2 13 14 15 16 3 4 5 7 9 11 12 18
26	1359	1.005	1.196	.889	.515	1.562	1.645	2 13 14 15 16 3 4 5 7 9 11 12 18
27	1272	1.000	1.196	.885	.514	1.559	1.642	2 13 14 15 16 3 4 5 7 9 11 12 18
28	1178	.996	1.196	.882	.514	1.556	1.639	2 13 14 15 16 3 4 5 7 9 11 12 18
29	1071	1.100	1.161	.880	.503	1.600	1.677	3 9 12 18 16 2 4 5 7 11 13 14
30	954	1.099	1.161	.879	.504	1.598	1.676	3 9 12 18 16 2 4 5 7 11 13 14
31	823	1.097	1.161	.877	.505	1.597	1.675	3 9 12 18 16 2 4 5 7 11 13 14
32	682	1.095	1.162	.876	.506	1.596	1.674	3 9 12 18 16 2 4 5 7 11 13 14
33	527	1.094	1.163	.875	.507	1.596	1.675	3 9 12 18 16 2 4 5 7 11 13 14
34	357	1.170	1.155	.832	.510	1.644	1.721	16 3 7 13 2 4 5 9 11 12 14
35	172	1.175	1.154	.832	.511	1.646	1.724	16 3 7 13 2 4 5 9 11 12 14

TERMINATION OF RUN. ALTITUDE APPROACHING ZERO

Appendix E
Selected Data Extracts

This section of the appendix contains some selected output from the numerous computer runs made and used in the analysis of the baseline constellation and its modification. The complete program output listing is provided for the global distribution run made for each of these satellite constellations. Portions of the output from several other runs, which were used in analyzing the effect of satellite losses on each constellation, have also been provided. Finally, extracts of output from several of the computer runs used in the analysis of the geometric performance for the space-based user are included as indicative of the performance obtainable for varying antenna half-angle beamwidths.

TABLE XXII

Global Distribution - Baseline Constellation

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
1	0.00	0.00	30.00	55.00	0.00	12.00
2	0.00	0.00	30.00	55.00	120.00	12.00
3	0.00	0.00	30.00	55.00	240.00	12.00
4	0.00	0.00	90.00	55.00	40.00	12.00
5	0.00	0.00	90.00	55.00	160.00	12.00
6	0.00	0.00	90.00	55.00	280.00	12.00
7	0.00	0.00	150.00	55.00	80.00	12.00
8	0.00	0.00	150.00	55.00	200.00	12.00
9	0.00	0.00	150.00	55.00	320.00	12.00
10	0.00	0.00	210.00	55.00	120.00	12.00
11	0.00	0.00	210.00	55.00	240.00	12.00
12	0.00	0.00	210.00	55.00	360.00	12.00
13	0.00	0.00	270.00	55.00	160.00	12.00
14	0.00	0.00	270.00	55.00	280.00	12.00
15	0.00	0.00	270.00	55.00	40.00	12.00
16	0.00	0.00	330.00	55.00	200.00	12.00
17	0.00	0.00	330.00	55.00	320.00	12.00
18	0.00	0.00	330.00	55.00	80.00	12.00

GLOBAL DISTRIBUTION CALCULATIONS

MASKING ANGLE = 5.00 DEGREES
LATITUDE STEP = 5.00 DEGREES
LATITUDE INCREMENT = 2
LONGITUDE INCREMENT = 2
DILUTION OF PRECISION PARAMETERS PRINTED AT TIME INCREMENT OF 0

TOTAL TIME(MIN) = 240
TIME INCREMENT(MIN) = 5

THE SATELLITE MOST NEARLY OVERHEAD IS USED AS ONE OF THE FOUR
IN ALL CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON

TABLE XXII (Continued)

ELEVATION DISTRIBUTION - PROBABILITY THAT THE SATELLITE IN VIEW WILL HAVE ELEVATION ANGLES AS LISTED

ELEVATION ANGLE

	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90
PROB	0.0	10.8	10.8	10.2	10.1	9.2	8.8	8.4	8.1	5.8	4.6	3.7	3.1	2.4	1.8	1.2	.8	.2

LATITUDE ELEVATION DISTRIBUTION
PROBABILITY THAT ANY SATELLITE IN VIEW WILL HAVE AN ELEVATION ANGLE GREATER THAN OR EQUAL TO THOSE LISTED

LATITUDE

ELEV ANGLE	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1 00
5	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00
10	.93	0.00	.91	0.00	.90	0.00	.88	0.00	.88	0.00	.90	0.00	.90	0.00	.88	0.00	.88	0.00	.88
15	81	0.00	.81	0.00	.79	0.00	.73	0.00	.77	0.00	.80	0.00	.79	0.00	.78	0.00	.76	0.00	.80
20	.73	0.00	.72	0.00	.68	0 00	.62	0.00	.68	0.00	.70	0.00	.71	0.00	.68	0.00	.65	0.00	.66
25	.62	0.00	.62	0.00	.54	0.00	.54	0.00	.59	0.00	.62	0.00	.62	0.00	.60	0.00	.56	0.00	.52
30	.55	0.00	.50	0.00	.44	0.00	.45	0.00	.51	0.00	.54	0.00	.54	0.00	.51	0.00	.47	0.00	.41
35	.43	0.00	.36	0.00	.35	0.00	.38	0.00	.44	0.00	.46	0.00	.46	0.00	.44	0.00	.36	0.00	.34
40	.28	0.00	.24	0.00	.28	0.00	.32	0.00	.38	0.00	.40	0.00	.40	0.00	.36	0.00	.29	0.00	.26
45	06	0.00	.16	0.00	.22	0 00	.26	0.00	.31	0.00	.34	0.00	.33	0.00	.29	0.00	.22	0.00	.21
50	0 00	0.00	.09	0.00	.16	0 00	.21	0.00	.26	0.00	.28	0.00	.27	0.00	.20	0.00	.17	0.00	17
55	0.00	0.00	.03	0.00	.11	0.00	.17	0.00	.21	0.00	.23	0.00	.21	0.00	.16	0.00	.12	0.00	.12
60	0.00	0.00	0.00	0.00	.07	0.00	.13	0.00	.16	0.00	.18	0.00	.14	0.00	.11	0.00	.10	0.00	09
65	0.00	0.00	0.00	0.00	.03	0.00	.09	0.00	.13	0.00	.13	0.00	.09	0.00	.08	0.00	.06	0.00	.05
70	0.00	0.00	0.00	0.00	.00	0.00	.06	0.00	.09	0.00	.09	0.00	.06	0.00	.04	0.00	.04	0.00	.04
75	0 00	0.00	0.00	0.00	0.00	0.00	.03	0.00	.06	0.00	.04	0.00	.03	0.00	.02	0.00	.02	0.00	.02
80	0 00	0.00	0.00	0.00	0.00	0.00	.01	0.00	.03	0.00	.02	0.00	.02	0.00	.01	0.00	.01	0.00	.01
85	0 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.01	0.00	.00	0.00	0.00	0.00	.00	0.00	.00	0.00	.00

ACCUMULATIVE ELEVATION DISTRIBUTION
PROBABILITY THAT THE ELEVATION ANGLE IS GREATER THAN OR EQUAL TO THOSE LISTED

ELEVATION ANGLE

	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
PROB	1 0	1.0	.9	.8	.7	.6	.5	.4	.3	.3	.2	2	.1	.1	.1	.0	.0	.0

TABLE XXII (Continued)

DILUTION OF PRECISION - ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT ALTITUDE DOP WILL BE GREATER THAN NUMBER LISTED

LATITUDE

NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.4	1.000	0.000	1.000	0.000	1.000	0.000	.993	0.000	1.000	0.000	1.000	0.000	.983	0.000	1.000	0.000	1.000	0.000	1.000
1.6	1.000	0.000	1.000	0.000	1.000	0.000	.778	0.000	.873	0.000	.925	0.000	.939	0.000	.948	0.000	.993	0.000	1.000
1.8	1.000	0.000	1.000	0.000	.771	0.000	.569	0.000	.776	0.000	.789	0.000	.764	0.000	.807	0.000	.813	0.000	.837
2.0	.878	0.000	.796	0.000	.664	0.000	.488	0.000	.492	0.000	.592	0.000	.569	0.000	.594	0.000	.467	0.000	.522
2.2	.816	0.000	.428	0.000	.583	0.000	.433	0.000	.299	0.000	.426	0.000	.385	0.000	.313	0.000	.288	0.000	.227
2.4	.694	0.000	.379	0.000	.535	0.000	.399	0.000	.245	0.000	.338	0.000	.351	0.000	.238	0.000	.168	0.000	.077
2.6	.571	0.000	.372	0.000	.474	0.000	.365	0.000	.181	0.000	.245	0.000	.299	0.000	.188	0.000	.118	0.000	.023
2.8	.429	0.000	.347	0.000	.420	0.000	.351	0.000	.141	0.000	.127	0.000	.141	0.000	.118	0.000	.098	0.000	0.000
3.0	.306	0.000	.313	0.000	.349	0.000	.302	0.000	.134	0.000	.104	0.000	.107	0.000	.091	0.000	.068	0.000	0.000
3.2	.184	0.000	.252	0.000	.315	0.000	.274	0.000	.104	0.000	.077	0.000	.070	0.000	.054	0.000	.054	0.000	0.000
3.4	.184	0.000	.170	0.000	.268	0.000	.209	0.000	.088	0.000	.063	0.000	.027	0.000	.027	0.000	.041	0.000	0.000
3.6	.061	0.000	.156	0.000	.206	0.000	.132	0.000	.088	0.000	.050	0.000	.007	0.000	.014	0.000	.034	0.000	0.000
3.8	0.000	0.000	.143	0.000	.179	0.000	.111	0.000	.068	0.000	.050	0.000	.007	0.000	0.000	0.000	.027	0.000	0.000
4.0	0.000	0.000	.061	0.000	.104	0.000	.077	0.000	.054	0.000	.043	0.000	.007	0.000	0.000	0.000	.020	0.000	0.000
4.2	0.000	0.000	.027	0.000	.070	0.000	.050	0.000	.048	0.000	.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.4	0.000	0.000	.027	0.000	.050	0.000	.036	0.000	.034	0.000	.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.6	0.000	0.000	0.000	0.000	.007	0.000	.023	0.000	.027	0.000	.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.8	0.000	0.000	0.000	0.000	0.000	0.000	.023	0.000	.007	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.0	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.2	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.4	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.6	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.8	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.0	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.2	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.4	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.8	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE XXII (Continued)

DILUTION OF PRECISION - ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT POSITION DOP IN HORIZONTAL PLANE WILL BE GREATER THAN NUMBER LISTED

	LATITUDE																		
NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.2	.939	0.000	.973	0.000	.930	0.000	.980	0.000	.991	0.000	1.000	0.000	1.000	0.000	1.000	0.000	.966	0.000	1.000
1.4	.061	0.000	.340	0.000	.415	0.000	.586	0.000	.880	0.000	.868	0.000	.689	0.000	.707	0.000	.433	0.000	.540
1.6	0.000	0.000	.082	0.000	.256	0.000	.367	0.000	.680	0.000	.449	0.000	.361	0.000	.179	0.000	.036	0.000	.095
1.8	0.000	0.000	.014	0.000	.166	0.000	.197	0.000	.170	0.000	.132	0.000	.061	0.000	.020	0.000	0.000	0.000	0.000
2.0	0.000	0.000	0.000	0.000	.098	0.000	.091	0.000	.082	0.000	.104	0.000	.034	0.000	.007	0.000	0.000	0.000	0.000
2.2	0.000	0.000	0.000	0.000	.034	0.000	.050	0.000	.048	0.000	.054	0.000	.014	0.000	0.000	0.000	0.000	0.000	0.000
2.4	0.000	0.000	0.000	0.000	.007	0.000	.023	0.000	.034	0.000	.054	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.6	0.000	0.000	0.000	0.000	0.000	0.000	.018	0.000	.020	0.000	.041	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.8	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	.014	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.0	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	.014	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.2	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.4	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.6	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.8	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE XXII (Continued)

DILUTION OF PRECISION - ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT LARGER COMPONENT OF POSITION DOP WILL BE GREATER THAN NUMBER LISTED

LATITUDE

NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.0	.630	0.000	.501	0.000	.707	0.000	.784	0.000	.977	0.000	.930	0.000	.939	0.000	.844	0.000	.834	0.000	.973
1.2	.020	0.000	.224	0.000	.311	0.000	.408	0.000	.705	0.000	.860	0.000	.458	0.000	.306	0.000	.093	0.000	.127
1.4	0.000	0.000	.027	0.000	.202	0.000	.154	0.000	.336	0.000	.145	0.000	.102	0.000	.041	0.000	.009	0.000	0.000
1.6	0.000	0.000	.007	0.000	.129	0.000	.063	0.000	.088	0.000	.118	0.000	.034	0.000	.020	0.000	0.000	0.000	0.000
1.8	0.000	0.000	0.000	0.000	.041	0.000	.029	0.000	.068	0.000	.098	0.000	.020	0.000	.007	0.000	0.000	0.000	0.000
2.0	0.000	0.000	0.000	0.000	.007	0.000	.016	0.000	.048	0.000	.061	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.2	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	.027	0.000	.048	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.4	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	.027	0.000	.041	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.6	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	.014	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.8	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	.014	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.0	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.2	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE XXII (Continued)

DILUTION OF PRECISION - ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT TIME DOP WILL BE GREATER THAN NUMBER LISTED

LATITUDE

NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.8	1.000	0.000	1.000	0.000	1.000	0.000	.905	0.000	.955	0.000	.980	0.000	.946	0.000	.980	0.000	.932	0.000	.973
1.0	.878	0.000	.803	0.000	.728	0.000	.639	0.000	.844	0.000	.816	0.000	.732	0.000	.633	0.000	.712	0.000	.728
1.2	.894	0.000	.379	0.000	.549	0.000	.474	0.000	.415	0.000	.458	0.000	.424	0.000	.401	0.000	.249	0.000	.281
1.4	.571	0.000	.372	0.000	.515	0.000	.413	0.000	.299	0.000	.349	0.000	.367	0.000	.270	0.000	.138	0.000	.014
1.6	.306	0.000	.347	0.000	.447	0.000	.351	0.000	.224	0.000	.295	0.000	.308	0.000	.179	0.000	.082	0.000	0.000
1.8	.184	0.000	.252	0.000	.365	0.000	.308	0.000	.154	0.000	.188	0.000	.229	0.000	.138	0.000	.068	0.000	0.000
2.0	.061	0.000	.252	0.000	.288	0.000	.268	0.000	.134	0.000	.111	0.000	.113	0.000	.077	0.000	.054	0.000	0.000
2.2	.061	0.000	.156	0.000	.227	0.000	.186	0.000	.095	0.000	.084	0.000	.050	0.000	.020	0.000	.048	0.000	0.000
2.4	0.000	0.000	.143	0.000	.193	0.000	.132	0.000	.068	0.000	.063	0.000	.023	0.000	0.000	0.000	.020	0.000	0.000
2.6	0.000	0.000	.048	0.000	.104	0.000	.070	0.000	.061	0.000	.050	0.000	0.000	0.000	0.000	0.000	.014	0.000	0.000
2.8	0.000	0.000	.027	0.000	.054	0.000	.050	0.000	.048	0.000	.050	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.0	0.000	0.000	0.000	0.000	.007	0.000	.016	0.000	.027	0.000	.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.2	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	.007	0.000	.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.4	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	.007	0.000	.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.6	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.8	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.2	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.4	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.6	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.8	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.0	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.2	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.4	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.6	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.8	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.0	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE XXII (Continued)

DILUTION OF PRECISION - ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT THREE DIMENSIONAL POSITION DOP WILL BE GREATER THAN NUMBER LISTED

LATITUDE

NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
2.0	1.000	0.000	1.000	0.000	1.000	0.000	.905	0.000	.977	0.000	1.000	0.000	.959	0.000	1.000	0.000	.993	0.000	1.000
2.2	1.000	0.000	1.000	0.000	.771	0.000	.680	0.000	.941	0.000	.959	0.000	.882	0.000	.878	0.000	.868	0.000	.959
2.4	.878	0.000	.714	0.000	.898	0.000	.578	0.000	.798	0.000	.798	0.000	.719	0.000	.712	0.000	.565	0.000	.594
2.6	.694	0.000	.379	0.000	.583	0.000	.467	0.000	.388	0.000	.508	0.000	.433	0.000	.401	0.000	.308	0.000	.240
2.8	.694	0.000	.379	0.000	.528	0.000	.406	0.000	.286	0.000	.385	0.000	.365	0.000	.252	0.000	.168	0.000	.077
3.0	.429	0.000	.347	0.000	.460	0.000	.365	0.000	.209	0.000	.288	0.000	.299	0.000	.188	0.000	.118	0.000	.014
3.2	.306	0.000	.313	0.000	.397	0.000	.342	0.000	.168	0.000	.141	0.000	.195	0.000	.145	0.000	.084	0.000	0.000
3.4	.184	0.000	.313	0.000	.358	0.000	.308	0.000	.141	0.000	.111	0.000	.127	0.000	.091	0.000	.068	0.000	0.000
3.6	.184	0.000	.252	0.000	.308	0.000	.274	0.000	.134	0.000	.098	0.000	.057	0.000	.048	0.000	.054	0.000	0.000
3.8	.061	0.000	.170	0.000	.247	0.000	.202	0.000	.095	0.000	.070	0.000	.027	0.000	.027	0.000	.034	0.000	0.000
4.0	.061	0.000	.156	0.000	.213	0.000	.172	0.000	.088	0.000	.057	0.000	.014	0.000	0.000	0.000	.027	0.000	0.000
4.2	0.000	0.000	.116	0.000	.159	0.000	.125	0.000	.088	0.000	.057	0.000	.007	0.000	0.000	0.000	.020	0.000	0.000
4.4	0.000	0.000	.041	0.000	.104	0.000	.070	0.000	.054	0.000	.043	0.000	.007	0.000	0.000	0.000	0.000	0.000	0.000
4.6	0.000	0.000	.027	0.000	.070	0.000	.050	0.000	.054	0.000	.043	0.000	.007	0.000	0.000	0.000	0.000	0.000	0.000
4.8	0.000	0.000	.020	0.000	.029	0.000	.029	0.000	.048	0.000	.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.0	0.000	0.000	0.000	0.000	.014	0.000	.023	0.000	.034	0.000	.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.2	0.000	0.000	0.000	0.000	.007	0.000	.023	0.000	.027	0.000	.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.4	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	.020	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.6	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.8	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.0	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.2	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.4	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.8	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	0.000	0.000	.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE XXII (Continued)

DILUTION OF PRECISION - ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT FOUR DIMENSIONAL POSITION DOP WILL BE GREATER THAN NUMBER LISTED

LATITUDE

NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
2.0	1.000	0.000	1.000	0.000	1.000	0.000	.993	0.000	.991	0.000	1.000	0.000	.993	0.000	1.000	0.000	1.000	0.000	1.000
2.2	1.000	0.000	1.000	0.000	.993	0.000	.846	0.000	.977	0.000	1.000	0.000	.952	0.000	.993	0.000	.980	0.000	1.000
2.4	1.000	0.000	1.000	0.000	.764	0.000	.673	0.000	.878	0.000	.912	0.000	.868	0.000	.864	0.000	.855	0.000	.948
2.6	.878	0.000	.723	0.000	.698	0.000	.578	0.000	.798	0.000	.803	0.000	.739	0.000	.707	0.000	.578	0.000	.594
2.8	.816	0.000	.406	0.000	.583	0.000	.481	0.000	.456	0.000	.549	0.000	.474	0.000	.463	0.000	.363	0.000	.390
3.0	.694	0.000	.379	0.000	.549	0.000	.440	0.000	.333	0.000	.413	0.000	.392	0.000	.306	0.000	.197	0.000	.132
3.2	.571	0.000	.372	0.000	.501	0.000	.392	0.000	.265	0.000	.356	0.000	.342	0.000	.231	0.000	.132	0.000	.023
3.4	.429	0.000	.347	0.000	.454	0.000	.365	0.000	.218	0.000	.288	0.000	.299	0.000	.179	0.000	.104	0.000	0.000
3.6	.306	0.000	.313	0.000	.410	0.000	.342	0.000	.175	0.000	.188	0.000	.229	0.000	.138	0.000	.082	0.000	0.000
3.8	.306	0.000	.313	0.000	.372	0.000	.308	0.000	.141	0.000	.127	0.000	.154	0.000	.111	0.000	.061	0.000	0.000
4.0	.184	0.000	.252	0.000	.322	0.000	.288	0.000	.141	0.000	.111	0.000	.091	0.000	.070	0.000	.054	0.000	0.000
4.2	.061	0.000	.238	0.000	.288	0.000	.259	0.000	.102	0.000	.091	0.000	.057	0.000	.048	0.000	.048	0.000	0.000
4.4	.061	0.000	.170	0.000	.240	0.000	.202	0.000	.095	0.000	.084	0.000	.043	0.000	.027	0.000	.034	0.000	0.000
4.6	.061	0.000	143	0.000	.213	0.000	.172	0.000	.095	0.000	.063	0.000	.007	0.000	.007	0.000	.027	0.000	0.000
4.8	0.000	0.000	.143	0.000	.186	0.000	.138	0.000	.088	0.000	.057	0.000	.007	0.000	0.000	0.000	.027	0.000	0.000
5.0	0.000	0.000	.061	0.000	.138	0.000	.084	0.000	.061	0.000	.050	0.000	.007	0.000	0.000	0.000	.014	0.000	0.000
5.2	0.000	0.000	.027	0.000	.091	0.000	.063	0.000	.054	0.000	.050	0.000	.007	0.000	0.000	0.000	0.000	0.000	0.000
5.4	0.000	0.000	.027	0.000	.070	0.000	.050	0.000	.054	0.000	.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.6	0.000	0.000	.024	0.000	.036	0.000	.029	0.000	.048	0.000	.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.8	0.000	0.000	0.000	0.000	.007	0.000	.023	0.000	.034	0.000	.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.0	0.000	0.000	0.000	0.000	.007	0.000	.023	0.000	.027	0.000	.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.2	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	.020	0.000	.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.4	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	.007	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.8	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0	0.000	0.000	0.000	0.000	0.000	0.000	.016	0.000	0.000	0.000	.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE XXII (Continued)

DILUTION OF PRECISION PARAMETERS - ACCUMULATIVE GLOBAL DISTRIBUTION

NUMBER	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP
0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.8	1.0000	1.0000	1.0000	.9593	1.0000	1.0000
1.0	1.0000	1.0000	.8772	.7294	1.0000	1.0000
1.2	1.0000	.9874	.3557	.3828	1.0000	1.0000
1.4	.9985	.6368	.0987	.2620	1.0000	1.0000
1.6	.9419	.2700	.0439	.2048	1.0000	1.0000
1.8	.7856	.0708	.0275	.1547	1.0000	1.0000
2.0	.5489	.0397	.0141	.1080	.9832	.9976
2.2	.3455	.0184	.0100	.0698	.8882	.9740
2.4	.2828	.0124	.0081	.0464	.6782	.8665
2.6	.2073	.0084	.0055	.0274	.3915	.6836
2.8	.1441	.0060	.0055	.0188	.2773	.4531
3.0	.1183	.0060	.0041	.0098	.2125	.3149
3.2	.0934	.0041	.0041	.0073	.1552	.2480
3.4	.0676	.0041	.0034	.0073	.1238	.2074
3.6	.0500	.0041	.0025	.0055	.0957	.1659
3.8	.0412	.0032	.0025	.0055	.0664	.1322
4.0	.0288	.0025	.0025	.0049	.0523	.1080
4.2	.0189	.0025	.0025	.0049	.0423	.0877
4.4	.0153	.0025	.0025	.0049	.0244	.0699
4.6	.0103	.0025	.0025	.0049	.0205	.0535
4.8	.0067	.0025	.0025	.0041	.0148	.0467
5.0	.0055	.0025	.0025	.0041	.0114	.0317
5.2	.0055	.0025	.0025	.0041	.0103	.0236
5.4	.0049	.0025	.0025	.0041	.0076	.0196
5.6	.0049	.0025	.0025	.0041	.0055	.0153
5.8	.0049	.0025	.0025	.0041	.0055	.0110
6.0	.0049	.0025	.0025	.0041	.0055	.0103
6.2	.0041	.0025	.0025	.0034	.0055	.0087
6.4	.0041	.0025	.0025	.0034	.0049	.0062
6.6	.0041	.0025	.0025	.0034	.0049	.0055
6.8	.0041	.0025	.0025	.0034	.0041	.0055
7.0	.0041	.0025	.0025	.0025	.0041	.0055

TABLE XXII (Continued)

LAT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	NUMBER OF SATELLITES															
PROBABILITY (IN PERCENT) OF SEEING EXACTLY N SATELLITES																
90.	0.00	0.00	0.00	0.00	0.00	0.00	69.39	0.00	30.61							
85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
80.	0.00	0.00	0.00	0.00	0.00	0.00	37.87	58.73	3.40							
75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
70.	0.00	0.00	0.00	0.00	0.00	2.95	54.65	25.62	16.78							
65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
60.	0.00	0.00	0.00	0.00	1.59	20.63	33.58	32.88	11.34							
55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
50.	0.00	0.00	0.00	0.00	0.00	26.98	65.99	7.03	0.00							
45.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
40	0.00	0.00	0.00	0.00	5.67	36.73	48.75	7.48	1.36							
35.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
30.	0.00	0.00	0.00	0.00	0.00	47.39	38.10	11.79	2.72							
25.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
20	0.00	0.00	0.00	0.00	0.00	25.62	53.06	21.32	0.00							
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
10	0.00	0.00	0.00	0.00	0.00	10.43	41.72	42.86	4.99							
5.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
0.	0.00	0.00	0.00	0.00	0.00	0.00	42.63	56.01	1.36							
PROBABILITY (IN PERCENT) OF SEEING N OR MORE SATELLITES																
90.	100.00	100.00	100.00	100.00	100.00	100.00	100.00	30.61	30.61							
85.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
80	100.00	100.00	100.00	100.00	100.00	100.00	100.00	62.13	3.40							
75.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
70.	100.00	100.00	100.00	100.00	100.00	100.00	97.05	42.40	16.78							
65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
60.	100.00	100.00	100.00	100.00	100.00	98.41	77.78	44.22	11.34							
55.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
50.	100.00	100.00	100.00	100.00	100.00	100.00	73.02	7.03	0.00							
45.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
40	100.00	100.00	100.00	100.00	100.00	94.33	57.60	8.84	1.36							
35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
30	100.00	100.00	100.00	100.00	100.00	100.00	52.61	14.51	2.72							
25.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
20.	100.00	100.00	100.00	100.00	100.00	100.00	74.38	21.32	0.00							
15.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
10	100.00	100.00	100.00	100.00	100.00	100.00	89.57	47.85	4.99							
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
0	100.00	100.00	100.00	100.00	100.00	100.00	100.00	57.37	1.36							
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT EXACTLY N SATELLITES WILL BE SEEN																
PROB	0.00	0.00	0.00	0.00	.83	21.27	46.40	28.01	3.49							
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT N OR MORE SATELLITES WILL BE SEEN																
PROB	100.00	100.00	100.00	100.00	100.00	99.17	77.90	31.50	3.49							

TABLE XXII (Continued)

MAXIMUM AND MINIMUM NUMBERS SEEN AT EACH LATITUDE & LONGITUDE

MAXIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	P	0	8	0	8	0
85.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80.	8	0	8	0	8	0	7	0	8	0	8	0	8	0	8	0	7	0	8	0	8	0	8	0	7	0	8	0	8	0	8	0	8	0	7	0
75.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0
65.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60.	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0
55.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0
45.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.	7	0	6	0	7	0	8	0	7	0	6	0	7	0	8	0	8	0	7	0	6	0	7	0	8	0	7	0	6	0	7	0	8	0	8	0
35.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	7	0	6	0	7	0	8	0	7	0	6	0	6	0	8	0	8	0	7	0	6	0	7	0	8	0	7	0	6	0	6	0	8	0	8	0
25.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.	7	0	7	0	7	0	7	0	6	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0	7	0	7	0	7	0	7	0
15.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	7	0	8	0	8	0	8	0	7	0	8	0	8	0	8	0	8	0	7	0	8	0	8	0	8	0	7	0	8	0	8	0	8	0	8	0
5.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.	7	0	8	0	7	0	8	0	8	0	8	0	8	0	7	0	8	0	7	0	8	0	7	0	8	0	8	0	8	0	8	0	7	0	8	0

MINIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	8	0	6	0	6	0	6	0	6	0
85.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80.	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0
75.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	5	0	6	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	6	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
65.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60.	4	0	5	0	4	0	5	0	4	0	4	0	4	0	4	0	4	0	4	0	5	0	4	0	5	0	4	0	4	0	4	0	4	0	4	0
55.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
45.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.	5	0	4	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0
35.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
25.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
15.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	5	0	6	0	6	0	5	0	5	0	6	0	6	0	6	0	5	0	5	0	6	0	6	0	5	0	5	0	6	0	6	0	6	0	5	0
5.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0

TABLE XXIII

Global Distribution - Modified Constellation

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
1	.07	0.00	30.00	55.00	0.00	12.00
2	.07	0.00	30.00	55.00	126.60	12.00
3	.07	0.00	30.00	55.00	233.40	12.00
4	.07	0.00	90.00	55.00	42.80	12.00
5	.07	0.00	90.00	55.00	160.30	12.00
6	.07	0.00	90.00	55.00	269.50	12.00
7	.07	0.00	150.00	55.00	83.80	12.00
8	.07	0.00	150.00	55.00	193.90	12.00
9	.07	0.00	150.00	55.00	310.00	12.00
10	.07	0.00	210.00	55.00	123.30	12.00
11	.07	0.00	210.00	55.00	230.00	12.00
12	.07	0.00	210.00	55.00	355.70	12.00
13	.07	0.00	270.00	55.00	161.40	12.00
14	.07	0.00	270.00	55.00	270.60	12.00
15	.07	0.00	270.00	55.00	44.10	12.00
16	.07	0.00	330.00	55.00	198.60	12.00
17	.07	0.00	330.00	55.00	315.90	12.00
18	.07	0.00	330.00	55.00	89.40	12.00

GLOBAL DISTRIBUTION CALCULATIONS

MASKING ANGLE = 5.00 DEGREES
LATITUDE STEP = 5.00 DEGREES
LATITUDE INCREMENT = 2
LONGITUDE INCREMENT = 2
DILUTION OF PRECISION PARAMETERS PRINTED AT TIME INCREMENT OF 0

TOTAL TIME(MIN) = 240
TIME INCREMENT(MIN) = 5

THE SATELLITE MOST NEARLY OVERHEAD IS USED AS ONE OF THE FOUR
IN ALL CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON

TABLE XXIII (Continued)

ELEVATION DISTRIBUTION - PROBABILITY THAT THE SATELLITE IN VIEW WILL HAVE ELEVATION ANGLES AS LISTED

ELEVATION ANGLE

	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90
PROB	0.0	11.0	10.6	10.5	10.0	9.3	8.6	8.2	8.2	6.2	4.1	3.7	3.3	2.4	1.6	1.3	.7	.3

LATITUDE ELEVATION DISTRIBUTION
PROBABILITY THAT ANY SATELLITE IN VIEW WILL HAVE AN ELEVATION ANGLE GREATER THAN OR EQUAL TO THOSE LISTED

LATITUDE

ELEV ANGLE	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00
5	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00
10	.91	0.00	.91	0.00	.90	0.00	.87	0.00	.87	0.00	.90	0.00	.87	0.00	.88	0.00	.88	0.00	.91
15	.82	0.00	.81	0.00	.79	0.00	.73	0.00	.77	0.00	.78	0.00	.79	0.00	.79	0.00	.76	0.00	.80
20	.73	0.00	.71	0.00	.68	0.00	.62	0.00	.66	0.00	.70	0.00	.70	0.00	.69	0.00	.65	0.00	.65
25	.63	0.00	.61	0.00	.54	0.00	.53	0.00	.59	0.00	.62	0.00	.60	0.00	.60	0.00	.55	0.00	.53
30	.52	0.00	.50	0.00	.44	0.00	.46	0.00	.51	0.00	.53	0.00	.52	0.00	.51	0.00	.47	0.00	.42
35	.42	0.00	.36	0.00	.35	0.00	.38	0.00	.43	0.00	.46	0.00	.46	0.00	.44	0.00	.37	0.00	.35
40	.28	0.00	.24	0.00	.28	0.00	.32	0.00	.37	0.00	.40	0.00	.39	0.00	.37	0.00	.29	0.00	.27
45	.07	0.00	.16	0.00	.22	0.00	.27	0.00	.32	0.00	.33	0.00	.32	0.00	.28	0.00	.22	0.00	.21
50	0.00	0.00	.09	0.00	.16	0.00	.21	0.00	.25	0.00	.27	0.00	.26	0.00	.20	0.00	.17	0.00	.16
55	0.00	0.00	.03	0.00	.11	0.00	.17	0.00	.21	0.00	.23	0.00	.21	0.00	.16	0.00	.13	0.00	.12
60	0.00	0.00	0.00	0.00	.07	0.00	.12	0.00	.17	0.00	.18	0.00	.14	0.00	.11	0.00	.10	0.00	.09
65	0.00	0.00	0.00	0.00	.03	0.00	.09	0.00	.12	0.00	.13	0.00	.09	0.00	.07	0.00	.06	0.00	.06
70	0.00	0.00	0.00	0.00	.00	0.00	.06	0.00	.09	0.00	.08	0.00	.05	0.00	.04	0.00	.04	0.00	.04
75	0.00	0.00	0.00	0.00	0.00	0.00	.03	0.00	.06	0.00	.05	0.00	.03	0.00	.02	0.00	.02	0.00	.02
80	0.00	0.00	0.00	0.00	0.00	0.00	.01	0.00	.03	0.00	.02	0.00	.02	0.00	.01	0.00	.01	0.00	.01
85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.01	0.00	.00	0.00	.00	0.00	.00	0.00	.00	0.00	.00

ACCUMULATIVE ELEVATION DISTRIBUTION
PROBABILITY THAT THE ELEVATION ANGLE IS GREATER THAN OR EQUAL TO THOSE LISTED

ELEVATION ANGLE

	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
PROB	1.0	1.0	.9	.8	.7	.6	.5	.4	.3	.3	.2	.2	.1	.1	.1	.0	.0	.0

TABLE XXIII (Continued)

DILUTION OF PRECISION - ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT ALTITUDE DOP WILL BE GREATER THAN NUMBER LISTED

LATITUDE

NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.4	1.000	0.000	1.000	0.000	1.000	0.000	.989	0.000	.989	0.000	.989	0.000	.997	0.000	.989	0.000	1.000	0.000	1.000
1.6	1.000	0.000	1.000	0.000	.995	0.000	.888	0.000	.859	0.000	.909	0.000	.914	0.000	.950	0.000	.972	0.000	.973
1.8	1.000	0.000	1.000	0.000	.831	0.000	.644	0.000	.660	0.000	.764	0.000	.823	0.000	.829	0.000	.816	0.000	.756
2.0	.918	0.000	.799	0.000	.663	0.000	.494	0.000	.524	0.000	.577	0.000	.612	0.000	.582	0.000	.525	0.000	.545
2.2	.714	0.000	.463	0.000	.587	0.000	.399	0.000	.391	0.000	.430	0.000	.395	0.000	.401	0.000	.276	0.000	.308
2.4	.612	0.000	.390	0.000	.520	0.000	.347	0.000	.280	0.000	.338	0.000	.300	0.000	.284	0.000	.163	0.000	.147
2.6	.551	0.000	.381	0.000	.472	0.000	.310	0.000	.205	0.000	.227	0.000	.220	0.000	.243	0.000	.121	0.000	.077
2.8	.449	0.000	.349	0.000	.398	0.000	.280	0.000	.164	0.000	.137	0.000	.122	0.000	.179	0.000	.088	0.000	.048
3.0	.306	0.000	.308	0.000	.346	0.000	.230	0.000	.139	0.000	.096	0.000	.069	0.000	.139	0.000	.067	0.000	.040
3.2	.184	0.000	.235	0.000	.297	0.000	.187	0.000	.107	0.000	.084	0.000	.057	0.000	.109	0.000	.044	0.000	.037
3.4	.122	0.000	.180	0.000	.247	0.000	.142	0.000	.093	0.000	.071	0.000	.042	0.000	.086	0.000	.037	0.000	.037
3.6	.082	0.000	.132	0.000	.195	0.000	.095	0.000	.066	0.000	.057	0.000	.034	0.000	.062	0.000	.031	0.000	.033
3.8	0.000	0.000	.083	0.000	.145	0.000	.074	0.000	.052	0.000	.046	0.000	.025	0.000	.042	0.000	.019	0.000	.032
4.0	0.000	0.000	.062	0.000	.118	0.000	.050	0.000	.035	0.000	.032	0.000	.017	0.000	.026	0.000	.016	0.000	.029
4.2	0.000	0.000	.046	0.000	.075	0.000	.035	0.000	.025	0.000	.019	0.000	.006	0.000	.016	0.000	.012	0.000	.028
4.4	0.000	0.000	.031	0.000	.045	0.000	.024	0.000	.020	0.000	.016	0.000	0.000	0.000	.012	0.000	.010	0.000	.026
4.6	0.000	0.000	.020	0.000	.028	0.000	.020	0.000	.012	0.000	.015	0.000	0.000	0.000	.005	0.000	.007	0.000	.020
4.8	0.000	0.000	.014	0.000	.020	0.000	.015	0.000	.009	0.000	.014	0.000	0.000	0.000	.002	0.000	.005	0.000	.019
5.0	0.000	0.000	.010	0.000	.017	0.000	.014	0.000	.008	0.000	.010	0.000	0.000	0.000	0.000	0.000	.002	0.000	.011
5.2	0.000	0.000	.008	0.000	.014	0.000	.011	0.000	.001	0.000	.009	0.000	0.000	0.000	0.000	0.000	.002	0.000	.009
5.4	0.000	0.000	.005	0.000	.005	0.000	.010	0.000	0.000	0.000	.009	0.000	0.000	0.000	0.000	0.000	.002	0.000	.006
5.6	0.000	0.000	.003	0.000	0.000	0.000	.008	0.000	0.000	0.000	.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.006
5.8	0.000	0.000	.002	0.000	0.000	0.000	.008	0.000	0.000	0.000	.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.005
6.0	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.003
6.2	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.001
6.4	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.001
6.6	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.001
6.8	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE XXIII (Continued)

DILUTION OF PRECISION - ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT POSITION DOP IN HORIZONTAL PLANE WILL BE GREATER THAN NUMBER LISTED

LATITUDE

NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.2	.959	0.000	.951	0.000	.957	0.000	.959	0.000	.977	0.000	1.000	0.000	.997	0.000	.983	0.000	.991	0.000	.998
1.4	.102	0.000	.345	0.000	.477	0.000	.598	0.000	.825	0.000	.829	0.000	.729	0.000	.662	0.000	.460	0.000	.432
1.6	.020	0.000	.085	0.000	.271	0.000	.358	0.000	.588	0.000	.457	0.000	.359	0.000	.259	0.000	.125	0.000	.075
1.8	0.000	0.000	.025	0.000	.175	0.000	.166	0.000	.249	0.000	.170	0.000	.145	0.000	.087	0.000	.044	0.000	.029
2.0	0.000	0.000	.006	0.000	.091	0.000	.090	0.000	.126	0.000	.080	0.000	.039	0.000	.027	0.000	.012	0.000	.016
2.2	0.000	0.000	0.000	0.000	.043	0.000	.045	0.000	.071	0.000	.057	0.000	.008	0.000	.011	0.000	0.000	0.000	.006
2.4	0.000	0.000	0.000	0.000	.025	0.000	.028	0.000	.051	0.000	.039	0.000	.003	0.000	.007	0.000	0.000	0.000	.001
2.6	0.000	0.000	0.000	0.000	.007	0.000	.018	0.000	.025	0.000	.027	0.000	.001	0.000	.005	0.000	0.000	0.000	0.000
2.8	0.000	0.000	0.000	0.000	.002	0.000	.017	0.000	.015	0.000	.019	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000
3.0	0.000	0.000	0.000	0.000	0.000	0.000	.010	0.000	.005	0.000	.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.2	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	.002	0.000	.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.4	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.6	0.000	0.000	0.000	0.000	0.000	0.000	.006	0.000	0.000	0.000	.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.8	0.000	0.000	0.000	0.000	0.000	0.000	.006	0.000	0.000	0.000	.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0	0.000	0.000	0.000	0.000	0.000	0.000	.006	0.000	0.000	0.000	.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.2	0.000	0.000	0.000	0.000	0.000	0.000	.006	0.000	0.000	0.000	.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.4	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.6	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.8	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.0	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.2	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.4	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.6	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.8	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.0	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.2	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.4	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.8	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE XXIII (Continued)

DILUTION OF PRECISION - ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT LARGER COMPONENT OF POSITION DOP WILL BE GREATER THAN NUMBER LISTED

	LATITUDE																		
NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.0	.565	0.000	.494	0.000	.717	0.000	.764	0.000	.904	0.000	.912	0.000	.913	0.000	.821	0.000	.783	0.000	.808
1.2	.063	0.000	.180	0.000	.349	0.000	.391	0.000	.658	0.000	.667	0.000	.498	0.000	.382	0.000	.200	0.000	.180
1.4	.011	0.000	.045	0.000	.196	0.000	.181	0.000	.359	0.000	.245	0.000	.162	0.000	.113	0.000	.068	0.000	.036
1.6	0.000	0.000	.019	0.000	.109	0.000	.071	0.000	.133	0.000	.104	0.000	.044	0.000	.048	0.000	.024	0.000	.011
1.8	0.000	0.000	.003	0.000	.036	0.000	.036	0.000	.088	0.000	.069	0.000	.015	0.000	.020	0.000	.007	0.000	.002
2.0	0.000	0.000	0.000	0.000	.009	0.000	.025	0.000	.063	0.000	.052	0.000	.007	0.000	.012	0.000	.001	0.000	0.000
2.2	0.000	0.000	0.000	0.000	.006	0.000	.016	0.000	.041	0.000	.040	0.000	.002	0.000	.008	0.000	0.000	0.000	0.000
2.4	0.000	0.000	0.000	0.000	.001	0.000	.010	0.000	.023	0.000	.027	0.000	.001	0.000	.005	0.000	0.000	0.000	0.000
2.6	0.000	0.000	0.000	0.000	0.000	0.000	.009	0.000	.016	0.000	.019	0.000	0.000	0.000	.002	0.000	0.000	0.000	0.000
2.8	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	.006	0.000	.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.0	0.000	0.000	0.000	0.000	0.000	0.000	.007	0.000	.002	0.000	.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.2	0.000	0.000	0.000	0.000	0.000	0.000	.006	0.000	0.000	0.000	.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.4	0.000	0.000	0.000	0.000	0.000	0.000	.006	0.000	0.000	0.000	.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.6	0.000	0.000	0.000	0.000	0.000	0.000	.006	0.000	0.000	0.000	.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.8	0.000	0.000	0.000	0.000	0.000	0.000	.006	0.000	0.000	0.000	.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.2	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.4	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.6	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.8	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.0	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.2	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.4	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.6	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.8	0.000	0.000	0.000	0.000	0.000	0.000	.003	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.0	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.2	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.4	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.8	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0	0.000	0.000	0.000	0.000	0.000	0.000	.002	0.000	0.000	0.000	.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE XXIII (Continued)

DILUTION OF PRECISION - ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT TIME DOP WILL BE GREATER THAN NUMBER LISTED

	LATITUDE																		
NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.8	1.000	0.000	1.000	0.000	.995	0.000	.938	0.000	.941	0.000	.978	0.000	.965	0.000	.966	0.000	.965	0.000	.981
1.0	.878	0.000	.789	0.000	.755	0.000	.660	0.000	.745	0.000	.765	0.000	.743	0.000	.730	0.000	.694	0.000	.732
1.2	.612	0.000	.392	0.000	.565	0.000	.475	0.000	.483	0.000	.505	0.000	.468	0.000	.451	0.000	.299	0.000	.342
1.4	.510	0.000	.379	0.000	.502	0.000	.367	0.000	.310	0.000	.376	0.000	.337	0.000	.307	0.000	.147	0.000	.080
1.6	.367	0.000	.329	0.000	.425	0.000	.302	0.000	.235	0.000	.265	0.000	.265	0.000	.248	0.000	.098	0.000	.044
1.8	.204	0.000	.247	0.000	.346	0.000	.246	0.000	.163	0.000	.152	0.000	.168	0.000	.172	0.000	.067	0.000	.040
2.0	.122	0.000	.179	0.000	.281	0.000	.195	0.000	.129	0.000	.105	0.000	.075	0.000	.103	0.000	.040	0.000	.037
2.2	.020	0.000	.120	0.000	.215	0.000	.125	0.000	.101	0.000	.092	0.000	.037	0.000	.062	0.000	.028	0.000	.036
2.4	0.000	0.000	.068	0.000	.139	0.000	.079	0.000	.074	0.000	.078	0.000	.024	0.000	.042	0.000	.019	0.000	.033
2.6	0.000	0.000	.036	0.000	.075	0.000	.041	0.000	.051	0.000	.060	0.000	.009	0.000	.026	0.000	.010	0.000	.031
2.8	0.000	0.000	.019	0.000	.043	0.000	.029	0.000	.035	0.000	.039	0.000	.005	0.000	.019	0.000	.008	0.000	.026
3.0	0.000	0.000	.006	0.000	.020	0.000	.015	0.000	.014	0.000	.027	0.000	.001	0.000	.015	0.000	.006	0.000	.024
3.2	0.000	0.000	.005	0.000	.015	0.000	.008	0.000	.006	0.000	.020	0.000	0.000	0.000	.008	0.000	.002	0.000	.012
3.4	0.000	0.000	0.000	0.000	.009	0.000	.008	0.000	.003	0.000	.016	0.000	0.000	0.000	.007	0.000	0.000	0.000	.006
3.6	0.000	0.000	0.000	0.000	.003	0.000	.008	0.000	.001	0.000	.016	0.000	0.000	0.000	.002	0.000	0.000	0.000	.001
3.8	0.000	0.000	0.000	0.000	.001	0.000	.008	0.000	0.000	0.000	.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.001
4.0	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.2	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.4	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.6	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.8	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.0	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.2	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.4	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.6	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.8	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.0	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.2	0.000	0.000	0.000	0.000	0.000	0.000	.007	0.000	0.000	0.000	.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.4	0.000	0.000	0.000	0.000	0.000	0.000	.007	0.000	0.000	0.000	.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000	0.000	0.000	.007	0.000	0.000	0.000	.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.8	0.000	0.000	0.000	0.000	0.000	0.000	.006	0.000	0.000	0.000	.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0	0.000	0.000	0.000	0.000	0.000	0.000	.006	0.000	0.000	0.000	.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE XXIII (Continued)

DILUTION OF PRECISION - ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT THREE DIMENSIONAL POSITION DOP WILL BE GREATER THAN NUMBER LISTED

	LATITUDE																		
NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
2.0	1.000	0.000	1.000	0.000	1.000	0.000	.937	0.000	.965	0.000	.981	0.000	.976	0.000	.997	0.000	.999	0.000	1.000
2.2	1.000	0.000	.991	0.000	.830	0.000	.744	0.000	.901	0.000	.914	0.000	.930	0.000	.909	0.000	.889	0.000	.866
2.4	.898	0.000	.706	0.000	.698	0.000	.570	0.000	.673	0.000	.702	0.000	.745	0.000	.692	0.000	.580	0.000	.573
2.6	.673	0.000	.435	0.000	.601	0.000	.466	0.000	.500	0.000	.528	0.000	.500	0.000	.421	0.000	.307	0.000	.315
2.8	.592	0.000	.388	0.000	.524	0.000	.371	0.000	.339	0.000	.385	0.000	.311	0.000	.308	0.000	.185	0.000	.139
3.0	.510	0.000	.375	0.000	.461	0.000	.319	0.000	.244	0.000	.276	0.000	.253	0.000	.244	0.000	.130	0.000	.076
3.2	.347	0.000	.333	0.000	.398	0.000	.277	0.000	.186	0.000	.168	0.000	.175	0.000	.186	0.000	.093	0.000	.053
3.4	.245	0.000	.285	0.000	.347	0.000	.235	0.000	.154	0.000	.118	0.000	.086	0.000	.141	0.000	.061	0.000	.044
3.6	.163	0.000	.219	0.000	.295	0.000	.198	0.000	.124	0.000	.098	0.000	.058	0.000	.110	0.000	.046	0.000	.037
3.8	.102	0.000	.178	0.000	.244	0.000	.147	0.000	.109	0.000	.084	0.000	.050	0.000	.087	0.000	.036	0.000	.036
4.0	0.000	0.000	.100	0.000	.187	0.000	.110	0.000	.094	0.000	.070	0.000	.034	0.000	.068	0.000	.027	0.000	.033
4.2	0.000	0.000	.077	0.000	.153	0.000	.085	0.000	.078	0.000	.058	0.000	.025	0.000	.044	0.000	.019	0.000	.032
4.4	0.000	0.000	.060	0.000	.115	0.000	.060	0.000	.058	0.000	.049	0.000	.018	0.000	.032	0.000	.016	0.000	.031
4.6	0.000	0.000	.034	0.000	.076	0.000	.042	0.000	.044	0.000	.032	0.000	.010	0.000	.020	0.000	.011	0.000	.028
4.8	0.000	0.000	.026	0.000	.051	0.000	.028	0.000	.028	0.000	.024	0.000	.002	0.000	.012	0.000	.010	0.000	.026
5.0	0.000	0.000	.018	0.000	.031	0.000	.020	0.000	.023	0.000	.018	0.000	0.000	0.000	.005	0.000	.007	0.000	.023
5.2	0.000	0.000	.011	0.000	.023	0.000	.017	0.000	.012	0.000	.016	0.000	0.000	0.000	.002	0.000	.005	0.000	.020
5.4	0.000	0.000	.008	0.000	.019	0.000	.015	0.000	.009	0.000	.014	0.000	0.000	0.000	0.000	0.000	.002	0.000	.011
5.6	0.000	0.000	.005	0.000	.012	0.000	.012	0.000	.006	0.000	.011	0.000	0.000	0.000	0.000	0.000	.002	0.000	.007
5.8	0.000	0.000	.005	0.000	.009	0.000	.009	0.000	.002	0.000	.010	0.000	0.000	0.000	0.000	0.000	.001	0.000	.006
6.0	0.000	0.000	.005	0.000	.003	0.000	.008	0.000	.001	0.000	.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.005
6.2	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.003
6.4	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.001
6.6	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.001
6.8	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.001
7.0	0.000	0.000	0.000	0.000	0.000	0.000	.008	0.000	0.000	0.000	.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.001

TABLE XXIII (Continued)

DILUTION OF PRECISION - ACCUMULATIVE LATITUDE DISTRIBUTION
PROBABILITY THAT FOUR DIMENSIONAL POSITION DOP WILL BE GREATER THAN NUMBER LISTED

LATITUDE

NUM	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.2	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.4	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.6	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
1.8	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
2.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	.999	0.000	.994	0.000	1.000	0.000	1.000	0.000	1.000
2.2	1.000	0.000	1.000	0.000	.990	0.000	.910	0.000	.960	0.000	.969	0.000	.972	0.000	.993	0.000	.980	0.000	1.000
2.4	1.000	0.000	.991	0.000	.825	0.000	.732	0.000	.890	0.000	.901	0.000	.918	0.000	.897	0.000	.880	0.000	.859
2.6	.878	0.000	.727	0.000	.705	0.000	.598	0.000	.695	0.000	.710	0.000	.743	0.000	.707	0.000	.601	0.000	.591
2.8	.873	0.000	.440	0.000	.613	0.000	.501	0.000	.553	0.000	.544	0.000	.518	0.000	.492	0.000	.368	0.000	.407
3.0	.612	0.000	.392	0.000	.552	0.000	.409	0.000	.400	0.000	.459	0.000	.389	0.000	.342	0.000	.220	0.000	.186
3.2	.571	0.000	.384	0.000	.501	0.000	.348	0.000	.297	0.000	.357	0.000	.295	0.000	.289	0.000	.154	0.000	.092
3.4	.449	0.000	.370	0.000	.449	0.000	.312	0.000	.245	0.000	.280	0.000	.263	0.000	.245	0.000	.116	0.000	.061
3.6	.306	0.000	.324	0.000	.398	0.000	.278	0.000	.194	0.000	.184	0.000	.201	0.000	.197	0.000	.090	0.000	.048
3.8	.288	0.000	.283	0.000	.355	0.000	.245	0.000	.159	0.000	.124	0.000	.124	0.000	.160	0.000	.069	0.000	.043
4.0	.184	0.000	.237	0.000	.313	0.000	.218	0.000	.141	0.000	.109	0.000	.066	0.000	.121	0.000	.050	0.000	.040
4.2	.122	0.000	.183	0.000	.274	0.000	.180	0.000	.118	0.000	.096	0.000	.052	0.000	.099	0.000	.037	0.000	.037
4.4	.082	0.000	.155	0.000	.231	0.000	.134	0.000	.105	0.000	.083	0.000	.046	0.000	.080	0.000	.034	0.000	.036
4.6	.020	0.000	.100	0.000	.187	0.000	.110	0.000	.094	0.000	.075	0.000	.034	0.000	.067	0.000	.029	0.000	.033
4.8	0.000	0.000	.077	0.000	.160	0.000	.088	0.000	.078	0.000	.067	0.000	.027	0.000	.046	0.000	.019	0.000	.032
5.0	0.000	0.000	.063	0.000	.124	0.000	.068	0.000	.063	0.000	.056	0.000	.020	0.000	.035	0.000	.016	0.000	.031
5.2	0.000	0.000	.041	0.000	.088	0.000	.048	0.000	.051	0.000	.046	0.000	.012	0.000	.027	0.000	.014	0.000	.029
5.4	0.000	0.000	.029	0.000	.057	0.000	.032	0.000	.040	0.000	.037	0.000	.006	0.000	.018	0.000	.010	0.000	.028
5.6	0.000	0.000	.020	0.000	.041	0.000	.027	0.000	.027	0.000	.025	0.000	.001	0.000	.011	0.000	.007	0.000	.026
5.8	0.000	0.000	.014	0.000	.029	0.000	.020	0.000	.022	0.000	.022	0.000	0.000	0.000	.008	0.000	.006	0.000	.024
6.0	0.000	0.000	.011	0.000	.024	0.000	.017	0.000	.012	0.000	.018	0.000	0.000	0.000	.006	0.000	.005	0.000	.020
6.2	0.000	0.000	.007	0.000	.018	0.000	.014	0.000	.010	0.000	.018	0.000	0.000	0.000	.003	0.000	.002	0.000	.015
6.4	0.000	0.000	.005	0.000	.018	0.000	.012	0.000	.007	0.000	.018	0.000	0.000	0.000	.002	0.000	.002	0.000	.010
6.6	0.000	0.000	.005	0.000	.011	0.000	.009	0.000	.005	0.000	.014	0.000	0.000	0.000	0.000	0.000	.002	0.000	.006
6.8	0.000	0.000	.005	0.000	.007	0.000	.008	0.000	.002	0.000	.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.006
7.0	0.000	0.000	0.000	0.000	.003	0.000	.008	0.000	0.000	0.000	.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.005

TABLE XXIII (Continued)

DILUTION OF PRECISION PARAMETERS - ACCUMULATIVE GLOBAL DISTRIBUTION

NUMBER	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP
0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.8	1.0000	1.0000	1.0000	.9673	1.0000	1.0000
1.0	1.0000	1.0000	.8260	.7297	1.0000	1.0000
1.2	1.0000	.9858	.3937	.4284	1.0000	1.0000
1.4	.9980	.6156	.1504	.2759	1.0000	1.0000
1.6	.9366	.2838	.0578	.2109	1.0000	1.0000
1.8	.7790	.1156	.0293	.1478	1.0000	1.0000
2.0	.5681	.0493	.0185	.1009	.9849	.9991
2.2	.3797	.0241	.0122	.0720	.8863	.9761
2.4	.2739	.0152	.0074	.0510	.6527	.8761
2.6	.2096	.0086	.0051	.0328	.4322	.6672
2.8	.1539	.0056	.0029	.0227	.2937	.4811
3.0	.1202	.0030	.0018	.0143	.2257	.3430
3.2	.0967	.0019	.0012	.0082	.1691	.2651
3.4	.0793	.0013	.0012	.0054	.1265	.2218
3.6	.0602	.0010	.0010	.0034	.1012	.1756
3.8	.0453	.0010	.0009	.0023	.0835	.1383
4.0	.0334	.0009	.0006	.0018	.0650	.1111
4.2	.0229	.0007	.0006	.0016	.0510	.0929
4.4	.0170	.0004	.0004	.0016	.0396	.0788
4.6	.0119	.0004	.0004	.0016	.0279	.0657
4.8	.0085	.0004	.0004	.0015	.0197	.0534
5.0	.0063	.0004	.0004	.0013	.0138	.0431
5.2	.0049	.0004	.0004	.0012	.0105	.0336
5.4	.0036	.0004	.0004	.0012	.0073	.0249
5.6	.0026	.0004	.0004	.0012	.0053	.0180
5.8	.0024	.0004	.0004	.0011	.0039	.0145
6.0	.0022	.0004	.0003	.0011	.0029	.0114
6.2	.0018	.0004	.0003	.0010	.0022	.0085
6.4	.0017	.0003	.0003	.0010	.0018	.0070
6.6	.0015	.0003	.0003	.0010	.0018	.0049
6.8	.0012	.0003	.0003	.0009	.0017	.0037
7.0	.0012	.0003	.0003	.0009	.0017	.0028

TABLE XXIII (Continued)

MAXIMUM AND MINIMUM NUMBERS SEEN AT EACH LATITUDE & LONGITUDE

MAXIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0
85.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80.	7	0	8	0	8	0	8	0	7	0	8	0	8	0	8	0	7	0	8	0	8	0	7	0	7	0	8	0	8	0	8	0	8	0	7	0
75.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0
65.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60.	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0
55.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0	7	0	7	0	7	0	6	0	7	0	7	0	7	0	7	0	7	0
45.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.	7	0	6	0	6	0	8	0	7	0	7	0	6	0	8	0	8	0	7	0	7	0	6	0	8	0	7	0	6	0	6	0	8	0	8	0
35.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	7	0	7	0	6	0	7	0	7	0	7	0	6	0	8	0	8	0	7	0	7	0	6	0	7	0	7	0	7	0	6	0	7	0	7	0
25.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.	6	0	8	0	7	0	7	0	6	0	8	0	8	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0	8	0	8	0	7	0	7	0
15.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	7	0	5	0	7	0	8	0	8	0	8	0	8	0	7	0	7	0	7	0	8	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0
5.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.	7	0	8	0	7	0	7	0	8	0	7	0	7	0	7	0	8	0	7	0	8	0	7	0	8	0	7	0	8	0	8	0	7	0	7	0

MINIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0
85.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80.	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0
75.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	5	0	6	0	6	0	5	0	5	0	5	0	6	0	5	0	5	0	5	0	6	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
65.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60.	4	0	5	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	4	0	6	0	5	0	5	0	4	0	6	0	5	0	5	0	5	0
55.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	4	0	5	0	5	0	5	0	4	0	4	0	4	0	5	0
45.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.	5	0	4	0	4	0	5	0	5	0	4	0	4	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0
35.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	5	0	5	0	4	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
25.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.	5	0	5	0	4	0	4	0	5	0	5	0	5	0	4	0	5	0	5	0	5	0	4	0	4	0	5	0	5	0	5	0	4	0	5	0
15.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	5	0	6	0	6	0	6	0	5	0	6	0	6	0	6	0	5	0	5	0	6	0	6	0	5	0	5	0	6	0	6	0	5	0	5	0
5.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.	6	0	5	0	5	0	5	0	6	0	6	0	5	0	5	0	5	0	6	0	5	0	5	0	5	0	6	0	6	0	5	0	5	0	5	0

TABLE XXIII (Continued)

	NUMBER OF SATELLITES															
LAT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PROBABILITY (IN PERCENT) OF SEEING EXACTLY N SATELLITES																
90	0.00	0.00	0.00	0.00	0.00	0.00	59.18	18.33	24.49							
85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
80	0.00	0.00	0.00	0.00	0.00	0.00	38.78	57.71	3.51							
75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
70	0.00	0.00	0.00	0.00	0.00	3.97	53.63	27.44	14.97							
65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
60	0.00	0.00	0.00	0.00	.79	16.67	41.27	31.07	10.20							
55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
50	0.00	0.00	0.00	0.00	.68	29.25	57.60	12.47	0.00							
45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
40	0.00	0.00	0.00	0.00	4.88	33.11	54.76	5.67	1.59							
35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
30	0.00	0.00	0.00	0.00	.11	36.39	48.53	14.74	.23							
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
20	0.00	0.00	0.00	0.00	2.15	23.36	53.63	19.50	1.36							
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
10	0.00	0.00	0.00	0.00	0.00	5.56	49.21	43.20	2.04							
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
0	0.00	0.00	0.00	0.00	0.00	3.29	44.10	50.79	1.81							
PROBABILITY (IN PERCENT) OF SEEING N OR MORE SATELLITES																
90	100.00	100.00	100.00	100.00	100.00	100.00	100.00	40.82	24.49							
85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
80	100.00	100.00	100.00	100.00	100.00	100.00	100.00	61.22	3.51							
75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
70	100.00	100.00	100.00	100.00	100.00	100.00	96.03	42.40	14.97							
65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
60	100.00	100.00	100.00	100.00	100.00	99.21	82.54	41.27	10.20							
55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
50	100.00	100.00	100.00	100.00	100.00	99.32	70.07	12.47	0.00							
45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
40	100.00	100.00	100.00	100.00	100.00	95.12	62.02	7.26	1.59							
35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
30	100.00	100.00	100.00	100.00	100.00	99.89	63.49	14.97	.23							
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
20	100.00	100.00	100.00	100.00	100.00	97.85	74.49	20.86	1.36							
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
10	100.00	100.00	100.00	100.00	100.00	100.00	94.44	45.24	2.04							
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
0	100.00	100.00	100.00	100.00	100.00	100.00	96.71	52.61	1.81							
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT EXACTLY N SATELLITES WILL BE SEEN																
PROB	0.00	0.00	0.00	0.00	1.08	18.68	49.83	27.63	2.79							
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT N OR MORE SATELLITES WILL BE SEEN																
PROB	100.00	100.00	100.00	100.00	100.00	98.92	80.25	30.42	2.79							

TABLE XXIV
Global Distribution - Baseline 17

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
1	.000	.00	30.00	55.00	120.00	12.00
2	.000	.00	30.00	55.00	240.00	12.00
3	.000	.00	90.00	55.00	40.00	12.00
4	.000	.00	90.00	55.00	160.00	12.00
5	.000	.00	90.00	55.00	280.00	12.00
6	.000	.00	150.00	55.00	80.00	12.00
7	.000	.00	150.00	55.00	200.00	12.00
8	.000	.00	150.00	55.00	320.00	12.00
9	.000	.00	210.00	55.00	120.00	12.00
10	.000	.00	210.00	55.00	240.00	12.00
11	.000	.00	210.00	55.00	360.00	12.00
12	.000	.00	270.00	55.00	180.00	12.00
13	.000	.00	270.00	55.00	280.00	12.00
14	.000	.00	270.00	55.00	40.00	12.00
15	.000	.00	330.00	55.00	200.00	12.00
16	.000	.00	330.00	55.00	320.00	12.00
17	.000	.00	330.00	55.00	80.00	12.00

GLOBAL DISTRIBUTION CALCULATIONS

MASKING ANGLE = 5.00 DEGREES
LATITUDE STEP = 10.00 DEGREES
LATITUDE INCREMENT = 2
LONGITUDE INCREMENT = 2
DILUTION OF PRECISION PARAMETERS PRINTED AT TIME INCREMENT OF 0

TOTAL TIME(MIN) = 360
TIME INCREMENT(MIN) = 10

THE SATELLITE MOST NEARLY OVERHEAD IS USED AS ONE OF THE FOUR
IN ALL CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON

TABLE XXIV (Continued)

DILUTION OF PRECISION PARAMETERS - ACCUMULATIVE GLOBAL DISTRIBUTION

NUMBER	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP
.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.8	1.0000	1.0000	1.0000	.9604	1.0000	1.0000
1.0	1.0000	1.0000	.8868	.7933	1.0000	1.0000
1.2	1.0000	.9824	.4412	.4463	1.0000	1.0000
1.4	.9998	.6602	.2119	.3468	1.0000	1.0000
1.6	.9590	.3729	.0929	.2837	1.0000	1.0000
1.8	.8156	.1439	.0632	.2315	1.0000	1.0000
2.0	.5841	.0877	.0469	.1794	.9876	.9973
2.2	.4281	.0568	.0320	.1310	.9075	.9822
2.4	.3545	.0383	.0255	.0952	.7388	.8885
2.6	.2869	.0289	.0226	.0754	.4735	.7433
2.8	.2282	.0258	.0204	.0605	.3648	.5148
3.0	.1954	.0222	.0134	.0391	.2998	.4057
3.2	.1558	.0153	.0119	.0277	.2465	.3350
3.4	.1303	.0138	.0113	.0228	.2020	.2957
3.6	.0976	.0121	.0108	.0185	.1713	.2573
3.8	.0872	.0110	.0106	.0169	.1282	.2143
4.0	.0769	.0106	.0101	.0151	.1073	.1838
4.2	.0646	.0106	.0101	.0146	.0910	.1553
4.4	.0530	.0103	.0090	.0138	.0749	.1337
4.6	.0400	.0099	.0082	.0138	.0684	.1040
4.8	.0278	.0092	.0080	.0133	.0557	.0938
5.0	.0254	.0086	.0076	.0127	.0449	.0808
5.2	.0243	.0082	.0073	.0125	.0400	.0714
5.4	.0232	.0076	.0069	.0124	.0329	.0676
5.6	.0217	.0069	.0064	.0116	.0262	.0570
5.8	.0209	.0066	.0059	.0112	.0245	.0466
6.0	.0205	.0066	.0057	.0112	.0232	.0398
6.2	.0200	.0062	.0057	.0102	.0226	.0335
6.4	.0191	.0059	.0057	.0098	.0217	.0258
6.6	.0190	.0057	.0056	.0094	.0205	.0241
6.8	.0189	.0057	.0051	.0086	.0201	.0230
7.0	.0185	.0057	.0051	.0081	.0201	.0223

TABLE XXIV (Continued)

MAXIMUM AND MINIMUM NUMBERS SEEN AT EACH LATITUDE X LONGITUDE

MAXIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	8	0	8	0	8	0	8	0	7	0	7	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	7	0	7	0	6	0	6	0	6	0	6	0	6	0	7	0	6	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	8	0	7	0	6	0	7	0	7	0	6	0	6	0	8	0	7	0	7	0	7	0	7	0	8	0	8	0	7	0	6	0	7	0	7	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	7	0	7	0	7	0	6	0	6	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0	8	0	8	0	8	0	7	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10	8	0	7	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0	7	0	8	0
-20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	6	0	7	0	8	0	7	0	6	0	7	0	8	0	7	0	6	0	7	0	8	0	8	0	7	0	6	0	7	0	8	0	8	0	7	0
-40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0
-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0

MINIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	4	0	5	0	5	0	4	0	4	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	5	0	4	0	5	0	5	0	4	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	5	0	5	0	5	0	5	0	5	0	4	0	4	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	5	0	5	0	5	0	5	0	5	0	5	0	4	0	4	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	5	0	5	0	5	0	4	0	4	0	4	0	5	0	5	0	5	0	4	0	5	0	6	0	5	0	5	0	5	0	6	0	5	0	4	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10	4	0	4	0	5	0	5	0	5	0	5	0	4	0	4	0	5	0	5	0	5	0	5	0	6	0	6	0	5	0	5	0	5	0	5	0
-20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	4	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	5	0	4	0	5	0	5	0	5	0	5	0	4	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70	5	0	5	0	5	0	6	0	5	0	5	0	5	0	5	0	6	0	5	0	5	0	5	0	6	0	5	0	5	0	5	0	5	0	6	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0

TABLE XXIV (Continued)

NUMBER OF SATELLITES

LAT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PROBABILITY (IN PERCENT) OF SEEING EXACTLY N SATELLITES																
90	00	00	00	00	00	40 54	27 03	32 43	00							
80	00	00	00	00	00	00	00	00	00							
70	00	00	00	00	1 50	36 64	37 09	21 17	3 60							
60	00	00	00	00	00	00	00	00	00							
50	00	00	00	00	14 11	51 65	31 68	2 55	00							
40	00	00	00	00	00	00	00	00	00							
30	00	00	00	00	21 82	43 84	25 53	7 51	1 20							
20	00	00	00	00	00	00	00	00	00							
10	00	00	00	00	3 75	22 97	43 39	27 63	2 25							
0	00	00	00	00	00	00	00	00	00							
10	00	00	00	00	2 40	20 27	44 74	30 18	2 40							
20	00	00	00	00	00	00	00	00	00							
30	00	00	00	00	5 56	50 00	32 13	10 51	1 80							
40	00	00	00	00	00	00	00	00	00							
50	00	00	00	00	30	31 08	62 76	5 86	00							
60	00	00	00	00	00	00	00	00	00							
70	00	00	00	00	00	2 70	56 16	26 28	14 86							
80	00	00	00	00	00	00	00	00	00							
90	00	00	00	00	00	00	58 46	00	40 54							
PROBABILITY (IN PERCENT) OF SEEING N OR MORE SATELLITES																
90	100 00	100 00	100 00	100 00	100 00	100 00	59 46	32 43	00							
80	00	00	00	00	00	00	00	00	00							
70	100 00	100 00	100 00	100 00	100 00	98 50	61 86	24 77	3 60							
60	00	00	00	00	00	00	00	00	00							
50	100 00	100 00	100 00	100 00	100 00	85 89	34 23	2 55	00							
40	00	00	00	00	00	00	00	00	00							
30	100 00	100 00	100 00	100 00	100 00	78 64	34 23	8 71	1 20							
20	00	00	00	00	00	00	00	00	00							
10	100 00	100 00	100 00	100 00	100 00	96 25	73 27	29 88	2 25							
0	00	00	00	00	00	00	00	00	00							
10	100 00	100 00	100 00	100 00	100 00	97 60	77 33	32 58	2 40							
20	00	00	00	00	00	00	00	00	00							
30	100 00	100 00	100 00	100 00	100 00	94 44	44 44	12 31	1 80							
40	00	00	00	00	00	00	00	00	00							
50	100 00	100 00	100 00	100 00	100 00	99 70	68 62	5 86	00							
60	00	00	00	00	00	00	00	00	00							
70	100 00	100 00	100 00	100 00	100 00	100 00	97 30	41 14	14 86							
80	00	00	00	00	00	00	00	00	00							
90	100 00	100 00	100 00	100 00	100 00	100 00	100 00	40 54	40 54							
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT EXACTLY N SATELLITES WILL BE SEEN																
PROB	00	00	00	00	6 99	33 59	40 44	16 60	2 38							
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT N OR MORE SATELLITES WILL BE SEEN																
PROB	100 00	100 00	100 00	100 00	100 00	91 01	59 42	18 98	2 38							

TABLE XXV
Baseline 16 - Best Case

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
1	.000	.00	30.00	55.00	120.00	12.00
2	.000	.00	30.00	55.00	240.00	12.00
3	.000	.00	90.00	55.00	40.00	12.00
4	.000	.00	90.00	55.00	280.00	12.00
5	.000	.00	150.00	55.00	60.00	12.00
6	.000	.00	150.00	55.00	200.00	12.00
7	.000	.00	150.00	55.00	320.00	12.00
8	.000	.00	210.00	55.00	120.00	12.00
9	.000	.00	210.00	55.00	240.00	12.00
10	.000	.00	210.00	55.00	360.00	12.00
11	.000	.00	270.00	55.00	160.00	12.00
12	.000	.00	270.00	55.00	280.00	12.00
13	.000	.00	270.00	55.00	40.00	12.00
14	.000	.00	330.00	55.00	200.00	12.00
15	.000	.00	330.00	55.00	320.00	12.00
16	.000	.00	330.00	55.00	80.00	12.00

GLOBAL DISTRIBUTION CALCULATIONS

MASKING ANGLE = 5.00 DEGREES
LATITUDE STEP = 10.00 DEGREES
LATITUDE INCREMENT = 2
LONGITUDE INCREMENT = 2
DILUTION OF PRECISION PARAMETERS PRINTED AT TIME INCREMENT OF 0

TOTAL TIME(MIN) = 360
TIME INCREMENT(MIN) = 10

THE SATELLITE MO[illegible] [illegible]EARLY OVERHEAD IS USED AS ONE OF THE FOUR
IN ALL CALCULATI[illegible] OF THE VOLUME OF THE TETRAHEDRON

TABLE XXV (Continued)

DILUTION OF PRECISION PARAMETERS - ACCUMULATIVE GLOBAL DISTRIBUTION

NUMBER	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP
.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.8	1.0000	1.0000	1.0000	.9696	1.0000	1.0000
1.0	1.0000	1.0000	.8975	.8194	1.0000	1.0000
1.2	1.0000	.9846	.5110	.5173	1.0000	1.0000
1.4	.9995	.7078	.2796	.4017	1.0000	1.0000
1.6	.9674	.4349	.1458	.3364	1.0000	1.0000
1.8	.8445	.2087	.1025	.2814	1.0000	1.0000
2.0	.6360	.1377	.0803	.2299	.9914	.9983
2.2	.4843	.0964	.0573	.1782	.9314	.9878
2.4	.4101	.0689	.0456	.1399	.7837	.9170
2.6	.3432	.0515	.0402	.1151	.5424	.7885
2.8	.2803	.0461	.0350	.0937	.4273	.5846
3.0	.2443	.0384	.0275	.0688	.3652	.4703
3.2	.2074	.0305	.0244	.0565	.3053	.3969
3.4	.1791	.0281	.0233	.0466	.2608	.3553
3.6	.1463	.0249	.0225	.0386	.2271	.3135
3.8	.1310	.0229	.0222	.0351	.1851	.2729
4.0	.1144	.0222	.0212	.0319	.1609	.2398
4.2	.0987	.0220	.0212	.0310	.1390	.2114
4.4	.0846	.0216	.0190	.0285	.1187	.1887
4.6	.0698	.0208	.0171	.0285	.1066	.1578
4.8	.0562	.0190	.0168	.0276	.0891	.1426
5.0	.0515	.0179	.0159	.0263	.0765	.1240
5.2	.0493	.0171	.0152	.0260	.0696	.1131
5.4	.0466	.0159	.0142	.0257	.0602	.1051
5.6	.0448	.0140	.0131	.0239	.0530	.0916
5.8	.0430	.0133	.0122	.0228	.0497	.0797
6.0	.0422	.0133	.0117	.0228	.0478	.0690
6.2	.0411	.0125	.0117	.0209	.0466	.0614
6.4	.0386	.0122	.0117	.0201	.0446	.0525
6.6	.0384	.0117	.0115	.0189	.0415	.0492
6.8	.0382	.0117	.0106	.0178	.0407	.0474
7.0	.0376	.0117	.0106	.0167	.0407	.0460

TABLE XXV (Continued)

MAXIMUM AND MINIMUM NUMBERS SEEN AT EACH LATITUDE & LONGITUDE

MAXIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	8	0	8	0	7	0	7	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	6	0	7	0	6	0	6	0	6	0	6	0	6	0	7	0	6	0	6	0	6	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	7	0	6	0	6	0	7	0	7	0	6	0	6	0	8	0	7	0	7	0	7	0	6	0	7	0	8	0	7	0	6	0	6	0	7	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	6	0	7	0	7	0	6	0	6	0	7	0	7	0	7	0	7	0	7	0	7	0	8	0	7	0	7	0	7	0	7	0	7	0	7	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	7	0	6	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0	7	0	7	0	7	0	6	0	6	0	6	0	7	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	6	0	7	0	7	0	5	0	6	0	7	0	8	0	7	0	6	0	7	0	7	0	7	0	7	0	5	0	6	0	7	0	7	0	6	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	7	0	8	0	8	0	7	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0
-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	7	0	7	0	7	0	7	0	8	0	8	0	8	0	8	0	7	0	7	0	8	0	8	0	7	0	7	0	7	0	7	0	7	0	7	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0

MINIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	4	0	5	0	5	0	4	0	4	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	5	0	4	0	5	0	5	0	4	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	5	0	4	0	4	0	4	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	4	0	4	0	5	0	4	0	4	0	4	0	5	0	5	0	5	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	4	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	4	0	4	0	4	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	5	0	5	0	5	0	4	0	4	0	4	0	5	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	4	0	4	0	4	0	4	0	5	0	5	0	4	0	5	0	5	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	5	0	4	0	4	0	5	0	5	0	4	0	5	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	4	0	4	0	5	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0

TABLE XXV (Continued)

NUMBER OF SATELLITES

LAT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PROBABILITY (IN PERCENT) OF SEEING EXACTLY N SATELLITES																
90	00	00	00	00	00	40 54	27 03	32 43	00							
80	00	00	00	00	00	00	00	00	00							
70	00	00	00	00	1 50	37 69	37 09	21 92	1 80							
60	00	00	00	00	00	00	00	00	00							
50	00	00	00	00	15 47	56 61	26 28	1 65	00							
40	00	00	00	00	00	00	00	00	00							
30	00	00	00	00	28 08	44 74	21 32	5 28	60							
20	00	00	00	00	00	00	00	00	00							
10	00	00	00	00	6 46	31 87	46 85	14 41	45							
0	00	00	00	00	00	00	00	00	00							
10	00	00	00	00	6 01	32 13	48 50	12 76	60							
20	00	00	00	00	00	00	00	00	00							
30	00	00	00	00	27 03	45 65	21 62	5 41	30							
40	00	00	00	00	00	00	00	00	00							
50	00	00	00	00	13 36	56 31	28 83	1 50	00							
60	00	00	00	00	00	00	00	00	00							
70	00	00	00	00	1 50	35 89	40 84	19 67	2 10							
80	00	00	00	00	00	00	00	00	00							
90	00	00	00	00	00	40 54	18 92	32 43	8 11							
PROBABILITY (IN PERCENT) OF SEEING N OR MORE SATELLITES																
90	100 00	100 00	100 00	100 00	100 00	100 00	59 46	32 43	00							
80	00	00	00	00	00	00	00	00	00							
70	100 00	100 00	100 00	100 00	100 00	98 50	60 81	23 72	1 30							
60	00	00	00	00	00	00	00	00	00							
50	100 00	100 00	100 00	100 00	100 00	84 53	27 93	1 65	00							
40	00	00	00	00	00	00	00	00	00							
30	100 00	100 00	100 00	100 00	100 00	71 92	27 18	5 86	60							
20	00	00	00	00	00	00	00	00	00							
10	100 00	100 00	100 00	100 00	100 00	93 54	61 71	14 86	45							
0	00	00	00	00	00	00	00	00	00							
10	100 00	100 00	100 00	100 00	100 00	93 99	61 86	13 36	60							
20	00	00	00	00	00	00	00	00	00							
30	100 00	100 00	100 00	100 00	100 00	72 97	27 33	5 71	30							
40	00	00	00	00	00	00	00	00	00							
50	100 00	100 00	100 00	100 00	100 00	86 64	30 33	1 50	00							
60	00	00	00	00	00	00	00	00	00							
70	100 00	100 00	100 00	100 00	100 00	98 50	62 61	21 77	2 10							
80	00	00	00	00	00	00	00	00	00							
90	100 00	100 00	100 00	100 00	100 00	100 00	59 46	40 54	8 11							
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT EXACTLY N SATELLITES WILL BE SEEN																
PROB	00	00	00	00	14 03	42 14	34 06	9 21	56							
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT N OR MORE SATELLITES WILL BE SEEN																
PROB	100 00	100 00	100 00	100 00	100 00	85 97	43 83	9 77	56							

TABLE XXVI
Baseline 16 - Worst Case

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
1	.000	.00	30.00	55.00	120.00	12.00
2	.000	.00	30.00	55.00	240.00	12.00
3	.000	.00	90.00	55.00	40.00	12.00
4	.000	.00	90.00	55.00	160.00	12.00
5	.000	.00	90.00	55.00	280.00	12.00
6	.000	.00	150.00	55.00	80.00	12.00
7	.000	.00	150.00	55.00	200.00	12.00
8	.000	.00	150.00	55.00	320.00	12.00
9	.000	.00	210.00	55.00	240.00	12.00
10	.000	.00	210.00	55.00	360.00	12.00
11	.000	.00	270.00	55.00	160.00	12.00
12	.000	.00	270.00	55.00	280.00	12.00
13	.000	.00	270.00	55.00	40.00	12.00
14	.000	.00	330.00	55.00	200.00	12.00
15	.000	.00	330.00	55.00	320.00	12.00
16	.000	.00	330.00	55.00	80.00	12.00

GLOBAL DISTRIBUTION CALCULATIONS

MASKING ANGLE = 5.00 DEGREES
LATITUDE STEP = 10.00 DEGREES
LATITUDE INCREMENT = 2
LONGITUDE INCREMENT = 2
DILUTION OF PRECISION PARAMETERS PRINTED AT TIME INCREMENT OF 0

TOTAL TIME(MIN) = 360
TIME INCREMENT(MIN) = 10

THE SATELLITE MOST NEARLY OVERHEAD IS USED AS ONE OF THE FOUR
IN ALL CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON

TABLE XXVI (Continued)

DILUTION OF PRECISION PARAMETERS - ACCUMULATIVE GLOBAL DISTRIBUTION

NUMBER	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1 0000	1.0000	1.0000	1.0000	1.0000	1.0000
.6	1.0000	1 0000	1 0000	1 0000	1.0000	1.0000
.8	1.0000	1.0000	1.0000	.9673	1.0000	1.0000
1 0	1.0000	1.0000	.9028	.8211	1.0000	1.0000
1.2	1.0000	.9857	.5150	.5147	1.0000	1.0000
1 4	9995	.7099	.3006	.4143	1.0000	1.0000
1.6	9670	.4468	.1751	3503	1.0000	1.0000
1 8	8461	.2363	.1360	2978	1.0000	1.0000
2 0	.6372	.1701	.1129	.2488	.9907	.9985
2.2	.4927	.1297	.0918	.1958	.9297	.9865
2.4	.4240	.1044	.0811	.1596	.7781	.9161
2 6	.3576	.0885	.0757	1371	.5450	.7829
2.8	2990	.0812	.0695	1196	.4429	.5833
3 0	.2650	.0741	.0626	.0983	.3794	.4823
3.2	2283	.0666	.0581	.0867	.3244	.4137
3 4	.1994	.0621	.0546	.0785	.2811	.3725
3.6	.1682	.0589	.0534	.0698	.2478	.3318
3.8	.1562	.0533	.0518	.0647	.2056	.2819
4 0	1410	.0526	.0510	.0610	.1819	.2596
4 2	1271	.0517	.0508	0593	.1619	.2305
4 4	1149	.0513	.0487	.0588	.1460	.2084
4.6	.1030	.0505	.0470	.0588	.1370	.1768
4.8	0878	.0493	.0470	0574	.1222	.1638
5 0	.0822	.0485	.0458	.0565	.1127	.1486
5 2	0794	0477	.0455	0551	.1057	.1400
5 4	0771	.0466	.0445	0542	0945	.1344
5 6	0753	0442	.0422	0527	.0865	.1239
5.8	.0743	0435	.0415	.0508	.0830	.1122
6.0	.0733	.0431	.0406	.0503	.0800	.1052
6.2	0717	.0414	.0391	.0483	.0786	.0978
6 4	.0700	.0400	.0391	0478	.0768	.0890
6 6	0693	.0393	.0387	0468	.0734	.0839
6 8	0688	.0393	.0377	0463	.0725	.0802
7 0	0672	.0386	.0370	.0444	.0725	.0778

TABLE XXVI (Continued)

MAXIMUM AND MINIMUM NUMBERS SEEN AT EACH LATITUDE X LONGITUDE

MAXIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	8	0	8	0	7	0	7	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	7	0	7	0	6	0	6	0	6	0	6	0	6	0	7	0	6	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	8	0	7	0	6	0	6	0	7	0	6	0	6	0	8	0	7	0	7	0	7	0	7	0	8	0	8	0	7	0	6	0	6	0	7	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	6	0	6	0	6	0	5	0	6	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0	7	0	7	0	8	0	7	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10	7	0	6	0	6	0	6	0	6	0	7	0	7	0	8	0	8	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0	7	0	7	0
-20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-30	5	0	6	0	7	0	6	0	6	0	7	0	8	0	7	0	6	0	7	0	8	0	8	0	7	0	6	0	7	0	7	0	7	0	6	0
-40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50	6	0	6	0	6	0	6	0	6	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0	6	0	7	0	6	0
-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70	7	0	7	0	7	0	7	0	8	0	8	0	8	0	8	0	7	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	7	0
-80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0

MINIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	4	0	4	0	4	0	4	0	4	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	5	0	4	0	5	0	4	0	4	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	3	0	4	0	3	0	3	0	3	0	4	0	4	0	4	0	4	0	4	0	4	0	5	0	5	0	5	0	5	0	4	0	3	0	3	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	3	0	3	0	3	0	3	0	4	0	4	0	4	0	4	0	4	0	4	0	5	0	5	0	5	0	4	0	4	0	4	0	3	0	3	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	4	0	4	0	4	0	3	0	4	0	4	0	5	0	5	0	5	0	4	0	5	0	6	0	5	0	5	0	5	0	5	0	4	0	3	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10	3	0	3	0	4	0	4	0	4	0	4	0	4	0	4	0	5	0	5	0	5	0	5	0	6	0	6	0	5	0	4	0	5	0	4	0
-20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-30	4	0	4	0	4	0	4	0	3	0	3	0	3	0	3	0	3	0	4	0	5	0	5	0	5	0	5	0	5	0	4	0	4	0	4	0
-40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50	4	0	4	0	4	0	4	0	4	0	4	0	3	0	4	0	4	0	5	0	5	0	5	0	5	0	5	0	4	0	4	0	4	0	4	0
-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70	5	0	4	0	4	0	5	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	5	0	5	0	5	0	5	0	4	0	4	0	5	0
-80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0

TABLE XXVI (Continued)

NUMBER OF SATELLITES

LAT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PROBABILITY (IN PERCENT) OF SEEING EXACTLY N SATELLITES																
90	.00	.00	.00	.00	.00	54.05	21.62	24.32	.00							
80	.00	.00	.00	.00	.00	.00	.00	.00	.00							
70	.00	.00	.00	.00	6.91	37.54	37.84	15.92	1.80							
60	.00	.00	.00	.00	.00	.00	.00	.00	.00							
50	.00	.00	.00	3.45	22.07	45.20	26.88	2.40	.00							
40	.00	.00	.00	.00	.00	.00	.00	.00	.00							
30	.00	.00	.00	7.68	21.92	41.74	21.47	6.01	1.20							
20	.00	.00	.00	.00	.00	.00	.00	.00	.00							
10	.00	.00	.00	1.20	11.86	27.93	36.49	21.17	1.35							
0	.00	.00	.00	.00	.00	.00	.00	.00	.00							
-10	.00	.00	.00	1.20	9.31	30.63	36.19	21.17	1.50							
-20	.00	.00	.00	.00	.00	.00	.00	.00	.00							
-30	.00	.00	.00	2.40	22.22	43.99	23.57	6.91	.90							
-40	.00	.00	.00	.00	.00	.00	.00	.00	.00							
-50	.00	.00	.00	.15	13.21	46.10	37.69	2.85	.00							
-60	.00	.00	.00	.00	.00	.00	.00	.00	.00							
-70	.00	.00	.00	.00	1.05	29.88	42.49	20.87	5.71							
-80	.00	.00	.00	.00	.00	.00	.00	.00	.00							
-90	.00	.00	.00	.00	.00	29.73	28.73	24.32	18.22							
PROBABILITY (IN PERCENT) OF SEEING N OR MORE SATELLITES																
90	100.00	100.00	100.00	100.00	100.00	100.00	45.95	24.32	.00							
80	.00	.00	.00	.00	.00	.00	.00	.00	.00							
70	100.00	100.00	100.00	100.00	100.00	93.09	55.56	17.72	1.80							
60	.00	.00	.00	.00	.00	.00	.00	.00	.00							
50	100.00	100.00	100.00	100.00	96.55	74.47	29.28	2.40	.00							
40	.00	.00	.00	.00	.00	.00	.00	.00	.00							
30	100.00	100.00	100.00	100.00	92.34	70.42	28.68	7.21	1.20							
20	.00	.00	.00	.00	.00	.00	.00	.00	.00							
10	100.00	100.00	100.00	100.00	98.80	86.94	59.01	22.52	1.35							
0	.00	.00	.00	.00	.00	.00	.00	.00	.00							
-10	100.00	100.00	100.00	100.00	98.80	89.49	58.86	22.67	1.50							
-20	.00	.00	.00	.00	.00	.00	.00	.00	.00							
-30	100.00	100.00	100.00	100.00	97.60	75.38	31.38	7.81	.90							
-40	.00	.00	.00	.00	.00	.00	.00	.00	.00							
-50	100.00	100.00	100.00	100.00	99.85	86.64	40.54	2.85	.00							
-60	.00	.00	.00	.00	.00	.00	.00	.00	.00							
-70	100.00	100.00	100.00	100.00	100.00	98.95	69.07	26.58	5.71							
-80	.00	.00	.00	.00	.00	.00	.00	.00	.00							
-90	100.00	100.00	100.00	100.00	100.00	100.00	70.27	40.54	16.22							

ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT EXACTLY N SATELLITES WILL BE SEEN

	0	1	2	3	4	5	6	7	8
PROB	.00	.00	.00	2.36	14.90	37.67	31.66	12.14	1.27

ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT N OR MORE SATELLITES WILL BE SEEN

	0	1	2	3	4	5	6	7	8
PROB	100.00	100.00	100.00	100.00	97.64	82.74	45.07	13.41	1.27

TABLE XXVII
Baseline 15 - Best Case

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
1	.000	.00	30.00	55.00	.00	12.00
2	.000	.00	30.00	55.00	120.00	12.00
3	000	.00	30.00	55.00	240.00	12.00
4	000	.00	150.00	55.00	80.00	12.00
5	.000	.00	150.00	55.00	200.00	12.00
6	.000	.00	150.00	55.00	320.00	12.00
7	.000	.00	210.00	55.00	120.00	12.00
8	000	.00	210.00	55.00	240.00	12.00
9	.000	.00	210.00	55.00	360.00	12.00
10	.000	.00	270.00	55.00	160.00	12.00
11	.000	.00	270.00	55.00	280.00	12.00
12	.000	.00	270.00	55.00	40.00	12.00
13	.000	.00	330.00	55.00	200.00	12.00
14	000	.00	330.00	55.00	320.00	12.00
15	.000	.00	330.00	55.00	80.00	12.00

GLOBAL DISTRIBUTION CALCULATIONS

MASKING ANGLE = 5.00 DEGREES
LATITUDE STEP = 10.00 DEGREES
LATITUDE INCREMENT = 2
LONGITUDE INCREMENT = 2
DILUTION OF PRECISION PARAMETERS PRINTED AT TIME INCREMENT OF 0

TOTAL TIME(MIN) = 360
TIME INCREMENT(MIN) = 10

THE SATELLITE MOST NEARLY OVERHEAD IS USED AS ONE OF THE FOUR
IN ALL CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON

TABLE XXVII (Continued)

DILUTION OF PRECISION PARAMETERS - ACCUMULATIVE GLOBAL DISTRIBUTION

NUMBER	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP
.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.8	1.0000	1.0000	1.0000	.9721	1.0000	1.0000
1.0	1.0000	1.0000	.9024	.8344	1.0000	1.0000
1.2	1.0000	.9828	.5749	.5592	1.0000	1.0000
1.4	1.0000	.7511	.3527	.4315	1.0000	1.0000
1.6	.9720	.5079	.2002	.3716	1.0000	1.0000
1.8	.8571	.2752	.1449	.3259	1.0000	1.0000
2.0	.6701	.1860	.1150	.2738	.9926	.9983
2.2	.5212	.1359	.0885	.2301	.9408	.9890
2.4	.4495	.1035	.0738	.1821	.8305	.9246
2.6	.3915	.0817	.0651	.1604	.6002	.8336
2.8	.3300	.0728	.0591	.1321	.4749	.6393
3.0	.2964	.0633	.0514	.1058	.4121	.5116
3.2	.2632	.0555	.0464	.0934	.3589	.4388
3.4	.2347	.0519	.0444	.0778	.3159	.3963
3.6	.2045	.0471	.0425	.0643	.2833	.3626
3.8	.1838	.0439	.0417	.0588	.2449	.3248
4.0	.1592	.0421	.0394	.0546	.2209	.2915
4.2	.1416	.0414	.0391	.0533	.1951	.2682
4.4	.1252	.0400	.0358	.0506	.1693	.2475
4.6	.1077	.0388	.0324	.0506	.1500	.2193
4.8	.0926	.0362	.0319	.0491	.1328	.2007
5.0	.0831	.0336	.0305	.0472	.1193	.1750
5.2	.0793	.0324	.0296	.0465	.1095	.1611
5.4	.0754	.0305	.0278	.0461	.0952	.1470
5.6	.0724	.0287	.0273	.0437	.0877	.1355
5.8	.0700	.0278	.0264	.0419	.0823	.1242
6.0	.0688	.0278	.0246	.0419	.0780	.1089
6.2	.0674	.0268	.0239	.0392	.0752	.0899
6.4	.0647	.0248	.0239	.0380	.0727	.0872
6.6	.0643	.0244	.0236	.0366	.0691	.0819
6.8	.0641	.0239	.0221	.0329	.0679	.0763
7.0	.0629	.0239	.0221	.0303	.0679	.0742

TABLE XXVII (Continued)

MAXIMUM AND MINIMUM NUMBERS SEEN AT EACH LATITUDE & LONGITUDE

MAXIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0
80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0
60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	7	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	7	0	6	0	6	0
40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	6	0	6	0	5	0	6	0	7	0	6	0	5	0	7	0	7	0	6	0	5	0	5	0	6	0	7	0	7	0	6	0	7	0	7	0
20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	6	0	7	0	7	0	6	0	6	0	7	0	6	0	6	0	6	0	6	0	6	0	7	0	6	0	6	0	7	0	7	0	7	0	7	0
0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10.	7	0	6	0	6	0	7	0	7	0	6	0	7	0	7	0	7	0	7	0	6	0	6	0	7	0	6	0	6	0	6	0	6	0	6	0
-20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-30.	6	0	7	0	6	0	6	0	6	0	6	0	7	0	7	0	6	0	7	0	7	0	6	0	6	0	5	0	6	0	7	0	7	0	6	0
-40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50.	6	0	6	0	5	0	6	0	6	0	7	0	6	0	6	0	7	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0
-60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70.	6	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0	7	0	7	0	7	0	7	0
-80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0

MINIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	4	0	4	0	5	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	5	0	4	0	4	0	5	0	5	0	4	0	5	0
60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0
40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	4	0	4	0	4	0	4	0	4	0	3	0	4	0	3	0	4	0	4	0	3	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0
20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	4	0	4	0	5	0	4	0	4	0	4	0	5	0	5	0	4	0	4	0	4	0	5	0	4	0	4	0	5	0	5	0	5	0	5	0
0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10.	4	0	4	0	4	0	5	0	5	0	4	0	5	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	4	0	4	0	5	0
-20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-30.	3	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	3	0	4	0	4	0	3	0	4	0
-40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50.	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0
-60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70.	4	0	4	0	4	0	5	0	4	0	4	0	5	0	4	0	5	0	5	0	4	0	4	0	5	0	4	0	4	0	4	0	4	0	4	0
-80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90.	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0

TABLE XXVII (Continued)

NUMBER OF SATELLITES

LAT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PROBABILITY (IN PERCENT) OF SEEING EXACTLY N SATELLITES																
90	00	.00	.00	.00	.00	67.57	8.11	24.32								
80	00	.00	.00	.00	.00	00	.00	.00								
70	.00	00	.00	.00	3.00	55.71	28.68	12.61								
60	.00	.00	.00	.00	.00	.00	.00	.00								
50.	.00	.00	.00	.00	31.83	52.85	15.02	.00								
40.	.00	.00	.00	.00	.00	.00	.00	.00								
30	.00	.00	.00	1.05	44.29	37.99	13.51	3.15								
20	.00	.00	.00	.00	.00	.00	.00	.00								
10.	.00	.00	.00	.00	9.16	50.45	36.04	4.35								
0	.00	.00	.00	.00	.00	.00	.00	.00								
-10	.00	.00	.00	.00	9.61	49.25	37.69	3.45								
-20.	.00	.00	.00	.00	.00	.00	.00	.00								
-30	.00	.00	.00	1.05	44.29	36.49	15.02	3.15								
-40	.00	.00	.00	.00	00	00	.00	.00								
-50	.00	00	.00	.00	30.48	55.11	14.11	.30								
60	.00	.00	.00	.00	.00	00	.00	.00								
-70	.00	.00	.00	00	3.15	59.91	27.18	9.76								
-80.	.00	.00	.00	.00	.00	.00	.00	.00								
-90	.00	.00	.00	.00	.00	59.46	16.22	24.32								
PROBABILITY (IN PERCENT) OF SEEING N OR MORE SATELLITES																
90.	100.00	100.00	100.00	100.00	100.00	100.00	32.43	24.32								
80.	00	.00	.00	.00	.00	.00	.00	.00								
70	100.00	100.00	100.00	100.00	100.00	97.00	41.29	12.61								
60	00	00	.00	.00	.00	.00	.00	.00								
50	100.00	100 00	100.00	100.00	100.00	68.17	15.32	.30								
40	.00	.00	00	.00	00	.00	.00	.00								
30	100.00	100.00	100.00	100.00	98.95	54.65	16.67	3.15								
20	00	.00	.00	.00	.00	.00	.00	.00								
10.	100 00	100.00	100.00	100.00	100.00	90.84	40.39	4.35								
0	00	.00	.00	.00	.00	.00	.00	.00								
-10	100.00	100.00	100.00	100.00	100.00	90.39	41.14	3.45								
20	00	.00	.00	.00	00	.00	.00	.00								
-30	100 00	100.00	100.00	100.00	98.95	54.65	18.17	3.15								
-40	00	00	.00	.00	.00	.00	.00	.00								
-50	100.00	100.00	100.00	100.00	100.00	69.52	14.41	.30								
-60.	00	.00	.00	.00	.00	.00	.00	.00								
70	100 00	100.00	100 00	100 00	100.00	96.85	36.94	9.76								
-80	00	.00	.00	.00	.00	00	.00	.00								
-90	100 00	100.00	100.00	100 00	100 00	100.00	40.54	24.32								

ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT EXACTLY N SATELLITES WILL BE SEEN

	0	1	2	3	4	5	6	7
PROB	00	.00	.00	.32	24 22	47.89	23.83	3.74

ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT N OR MORE SATELLITES WILL BE SEEN

	0	1	2	3	4	5	6	7
PROB	100 00	100.00	100.00	100.00	99.68	75.46	27.56	3.74

TABLE XXVIII

Baseline 15 - Worst Case

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANUM	PER
1	0.00	0.00	30.00	55.00	120.00	12.00
2	0.00	0.00	30.00	55.00	240.00	12.00
3	0.00	0.00	90.00	55.00	40.00	12.00
4	0.00	0.00	90.00	55.00	160.00	12.00
5	0.00	0.00	90.00	55.00	280.00	12.00
6	0.00	0.00	150.00	55.00	80.00	12.00
7	0.00	0.00	150.00	55.00	320.00	12.00
8	0.00	0.00	210.00	55.00	120.00	12.00
9	0.00	0.00	210.00	55.00	240.00	12.00
10	0.00	0.00	210.00	55.00	360.00	12.00
11	0.00	0.00	270.00	55.00	160.00	12.00
12	0.00	0.00	270.00	55.00	280.00	12.00
13	0.00	0.00	330.00	55.00	200.00	12.00
14	0.00	0.00	330.00	55.00	320.00	12.00
15	0.00	0.00	330.00	55.00	80.00	12.00

GLOBAL DISTRIBUTION CALCULATIONS

MASKING ANGLE = 5.00 DEGREES
LATITUDE STEP = 10.00 DEGREES
LATITUDE INCREMENT = 2
LONGITUDE INCREMENT = 2
DILUTION OF PRECISION PARAMETERS PRINTED AT TIME INCREMENT OF 0

TOTAL TIME(MIN) = 360
TIME INCREMENT(MIN) = 10

THE SATELLITE MOST NEARLY OVERHEAD IS USED AS ONE OF THE FOUR IN ALL CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON

TABLE XXVIII (Continued)

DILUTION OF PRECISION PARAMETERS - ACCUMULATIVE GLOBAL DISTRIBUTION

NUMBER	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP
0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.8	1.0000	1.0000	.9999	.9764	1.0000	1.0000
1.0	1.0000	1.0000	.9111	.8522	1.0000	1.0000
1.2	1.0000	.9865	.5770	.5824	1.0000	1.0000
1.4	.9997	.7424	.3798	.4921	1.0000	1.0000
1.6	.9740	.5113	.2596	.4308	1.0000	1.0000
1.8	.8698	.3220	.2156	.3815	1.0000	1.0000
2.0	.7016	.2519	.1915	.3350	.9936	.9986
2.2	.5754	.2129	.1694	.2900	.9430	.9904
2.4	.5078	.1869	.1567	.2558	.8211	.8289
2.6	.4414	.1660	.1487	.2237	.6159	.8235
2.8	.3899	.1572	.1407	.1938	.5224	.6513
3.0	.3532	.1461	.1316	.1690	.4656	.5598
3.2	.3209	.1365	.1262	.1574	.4124	.4953
3.4	.2910	.1305	.1237	.1454	.3720	.4551
3.6	.2578	.1278	.1215	.1376	.3399	.4175
3.8	.2369	.1261	.1202	.1305	.3061	.3823
4.0	.2175	.1225	.1178	.1275	.2820	.3524
4.2	.1997	.1203	.1165	.1258	.2594	.3265
4.4	.1861	.1189	.1151	.1236	.2335	.3065
4.6	.1726	.1176	.1130	.1224	.2186	.2780
4.8	.1619	.1151	.1119	.1212	.1966	.2613
5.0	.1577	.1126	.1101	.1197	.1829	.2397
5.2	.1548	.1116	.1091	.1193	.1754	.2251
5.4	.1526	.1099	.1071	.1190	.1672	.2125
5.6	.1508	.1087	.1048	.1180	.1623	.1977
5.8	.1474	.1078	.1045	.1176	.1611	.1869
6.0	.1459	.1067	.1037	.1160	.1584	.1777
6.2	.1435	.1052	.1037	.1137	.1550	.1702
6.4	.1418	.1046	.1037	.1121	.1510	.1631
6.6	.1411	.1039	.1035	.1100	.1482	.1602
6.8	.1402	.1034	.1024	.1080	.1468	.1573
7.0	.1393	.1028	.1012	.1069	.1454	.1532

TABLE XXVIII (Continued)

MAXIMUM AND MINIMUM NUMBERS SEEN AT EACH LATITUDE & LONGITUDE

MAXIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0
80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	6	0	6	0	6	0	6	0	6	0	6	0	6	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	8	0	8	0	7	0	7	0
60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	6	0	5	0	5	0	5	0	5	0	6	0	6	0	7	0	6	0	7	0	6	0	7	0	7	0	7	0	7	0	6	0	6	0	6	0
40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	6	0	5	0	5	0	6	0	5	0	5	0	6	0	8	0	7	0	7	0	7	0	6	0	7	0	8	0	7	0	6	0	6	0	6	0
20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	6	0	5	0	5	0	6	0	6	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0	7	0	7	0	7	0	6	0
0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10.	6	0	5	0	5	0	6	0	6	0	7	0	7	0	8	0	8	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0	6	0	6	0
-20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-30.	5	0	6	0	8	0	5	0	5	0	7	0	7	0	6	0	6	0	7	0	8	0	8	0	7	0	6	0	6	0	7	0	7	0	6	0
-40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50.	6	0	5	0	6	0	6	0	6	0	6	0	6	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0	6	0	6	0
-60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	8	0	8	0	7	0	7	0	7	0	7	0
-80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0

MINIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0
80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	3	0	4	0	4	0	3	0	3	0	4	0	4	0	4	0	4	0	3	0	4	0	4	0	3	0	4	0	4	0	4	0	4	0	3	0
60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	3	0	3	0	3	0	3	0	3	0	3	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	3	0	3	0
40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	2	0	3	0	2	0	2	0	3	0	3	0	3	0	4	0	4	0	4	0	5	0	4	0	4	0	4	0	4	0	4	0	3	0	3	0
20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	3	0	3	0	3	0	3	0	2	0	3	0	4	0	4	0	5	0	4	0	5	0	6	0	4	0	5	0	5	0	4	0	3	0	2	0
0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10.	3	0	3	0	3	0	3	0	3	0	4	0	3	0	4	0	5	0	5	0	5	0	5	0	6	0	6	0	3	0	4	0	4	0	3	0
-20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-30.	3	0	3	0	3	0	3	0	2	0	3	0	3	0	4	0	4	0	4	0	5	0	5	0	5	0	5	0	4	0	4	0	3	0	3	0
-40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50.	4	0	3	0	3	0	3	0	3	0	3	0	4	0	4	0	5	0	5	0	5	0	5	0	5	0	4	0	4	0	4	0	4	0	4	0
-60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70.	4	0	4	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	5	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0
-80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90.	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0

TABLE XXVIII (Continued)

	NUMBER OF SATELLITES															
LAT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PROBABILITY (IN PERCENT) OF SEEING EXACTLY N SATELLITES																
90.	0.00	0.00	0.00	0.00	27.03	27.03	37.84	8.11	0.00							
80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
70.	0.00	0.00	0.00	.90	24.62	35.44	31.23	6.01	1.80							
60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
50.	0.00	0.00	0.00	10.06	35.59	36.49	16.82	1.05	0.00							
40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
30.	0.00	0.00	1.65	18.52	27.33	33.63	16.22	4.05	.60							
20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
10.	0.00	0.00	1.20	7.66	17.87	24.77	30.33	17.27	.90							
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-10.	0.00	0.00	0.00	6.76	18.47	26.88	27.33	19.07	1.50							
-20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-30.	0.00	0.00	.60	9.18	26.13	38.94	21.02	5.56	.80							
-40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-50.	0.00	0.00	0.00	1.95	23.72	43.54	28.98	1.80	0.00							
-60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-70.	0.00	0.00	0.00	0.00	1.50	41.14	40.69	14.56	2.10							
-80.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-90.	0.00	0.00	0.00	0.00	0.00	43.24	16.22	40.54	0.00							
PROBABILITY (IN PERCENT) OF SEEING N OR MORE SATELLITES																
90.	100.00	100.00	100.00	100.00	100.00	72.97	45.95	8.11	0.00							
80.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
70.	100.00	100.00	100.00	100.00	99.10	74.47	39.04	7.81	1.80							
60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
50.	100.00	100.00	100.00	100.00	89.94	54.35	17.87	1.05	0.00							
40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
30.	100.00	100.00	100.00	98.35	81.83	54.50	20.87	4.65	.60							
20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
10.	100.00	100.00	100.00	98.80	91.14	73.27	48.50	18.17	.90							
0.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-10.	100.00	100.00	100.00	100.00	93.24	74.77	47.90	20.57	1.50							
-20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-30.	100.00	100.00	100.00	99.40	90.24	84.11	27.18	8.18	.60							
-40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-50.	100.00	100.00	100.00	100.00	98.05	74.32	30.78	1.80	0.00							
-60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-70	100.00	100.00	100.00	100.00	100.00	98.50	57.36	18.67	2.10							
-80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-90.	100.00	100.00	100.00	100.00	100.00	100.00	56.76	40.54	0.00							
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT EXACTLY N SATELLITES WILL BE SEEN																
PROB	0.00	0.00	.55	7.84	22.77	33.43	25.23	9.34	.84							
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT N OR MORE SATELLITES WILL BE SEEN																
PROB	100.00	100.00	100.00	99.46	91.61	68.84	35.40	10.18	.84							

TABLE XXIX
Global Distribution - Modified 17

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
1	.070	0.00	30.00	55.00	126.60	12.00
2	070	0.00	30.00	55.00	233.40	12.00
3	070	0.00	90.00	55.00	42.80	12.00
4	070	0.00	90.00	55.00	160 30	12.00
5	.070	0.00	90.00	55.00	269.50	12.00
6	.070	0.00	150.00	55.00	83.80	12.00
7	.070	0.00	150.00	55.00	193.90	12.00
8	070	0.00	150.00	55.00	310.00	12.00
9	070	0.00	210.00	55 00	123.30	12.00
10	070	0.00	210.00	55.00	230.00	12.00
11	.070	0.00	210.00	55.00	355.70	12.00
12	.070	0.00	270.00	55.00	161.40	12.00
13	.070	0.00	270.00	56.00	270.80	12.00
14	.070	0.00	270.00	55.00	44.10	12.00
15	070	0 00	330.00	55.00	198.60	12.00
16	070	0.00	330.00	55 00	315.90	12.00
17	.070	0.00	330.00	55.00	89.40	12.00

GLOBAL DISTRIBUTION CALCULATIONS

MASKING ANGLE = 5.00 DEGREES
LATITUDE STEP = 10.00 DEGREES
LATITUDE INCREMENT = 2
LONGITUDE INCREMENT = 2
DILUTION OF PRECISION PARAMETERS PRINTED AT TIME INCREMENT OF 0

TOTAL TIME(MIN) = 360
TIME INCREMENT(MIN) = 10

THE SATELLITE MOST NEARLY OVERHEAD IS USED AS ONE OF THE FOUR
IN ALL CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON

TABLE XXIX (Continued)

DILUTION OF PRECISION PARAMETERS - ACCUMULATIVE GLOBAL DISTRIBUTION

NUMBER	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP
0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.8	1.0000	1.0000	1.0000	.9702	1.0000	1.0000
1.0	1.0000	1.0000	.8664	.7722	1.0000	1.0000
1.2	1.0000	.9850	.4824	.5045	1.0000	1.0000
1.4	.9970	.6787	.2444	.3565	1.0000	1.0000
1.6	.9434	.3911	.1172	.2798	1.0000	1.0000
1.8	.8232	.1953	.0701	.2177	1.0000	1.0000
2.0	.6352	.1039	.0478	.1570	.9877	.9986
2.2	.4552	.0630	.0352	.1208	.9208	.9809
2.4	.3518	.0434	.0252	.0867	.7316	.9099
2.6	.2821	.0305	.0185	.0611	.5383	.7375
2.8	.2160	.0222	.0144	.0458	.3916	.5684
3.0	.1807	.0167	.0115	.0327	.3085	.4430
3.2	.1484	.0135	.0105	.0275	.2459	.3578
3.4	.1243	.0112	.0091	.0222	.1936	.3011
3.6	.1015	.0103	.0082	.0189	.1615	.2532
3.8	.0827	.0089	.0073	.0164	.1342	.2106
4.0	.0653	.0082	.0073	.0148	.1149	.1721
4.2	.0522	.0078	.0069	.0139	.0915	.1483
4.4	.0428	.0078	.0067	.0131	.0735	.1319
4.6	.0357	.0070	.0063	.0119	.0591	.1158
4.8	.0298	.0068	.0057	.0104	.0457	.0939
5.0	.0266	.0060	.0052	.0098	.0376	.0774
5.2	.0243	.0060	.0050	.0093	.0337	.0634
5.4	.0221	.0058	.0050	.0085	.0302	.0525
5.6	.0204	.0053	.0048	.0083	.0266	.0428
5.8	.0182	.0051	.0048	.0077	.0245	.0374
6.0	.0172	.0051	.0048	.0069	.0228	.0337
6.2	.0165	.0050	.0046	.0060	.0207	.0299
6.4	.0154	.0050	.0044	.0057	.0186	.0279
6.6	.0144	.0044	.0042	.0057	.0175	.0256
6.8	.0134	.0042	.0042	.0055	.0168	.0236
7.0	.0128	.0040	.0033	.0052	.0161	.0215

TABLE XXIX (Continued)

MAXIMUM AND MINIMUM NUMBERS SEEN AT EACH LATITUDE & LONGITUDE

MAXIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0
80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	7	0
60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	6	0	6	0	6	0	6	0	5	0	6	0	6	0	6	0	6	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0
40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	7	0	7	0	5	0	6	0	6	0	6	0	6	0	7	0	7	0	7	0	7	0	6	0	7	0	7	0	7	0	6	0	7	0	7	0
20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	8	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0	8	0	8	0	8	0	7	0
0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10.	8	0	7	0	6	0	7	0	7	0	6	0	7	0	8	0	8	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0	7	0	8	0
-20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-30.	7	0	7	0	7	0	6	0	7	0	7	0	7	0	6	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0
-40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0
-60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70.	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0
-80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90.	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0

MINIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	4	0	5	0	5	0	4	0	4	0	4	0	5	0	4	0	4	0	5	0	5	0	4	0	4	0	4	0	4	0	5	0	4	0	4	0
60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	4	0	4	0	4	0	4	0	4	0	4	0	4	0	3	0	4	0	4	0	4	0	4	0	5	0	5	0	4	0	4	0	4	0	4	0
40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	5	0	5	0	5	0	5	0	5	0	4	0	4	0
20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	5	0	5	0	5	0	5	0	4	0	4	0	5	0	5	0	5	0	4	0	5	0	6	0	5	0	5	0	5	0	6	0	5	0	4	0
0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10.	4	0	5	0	5	0	5	0	5	0	5	0	4	0	4	0	5	0	5	0	5	0	5	0	6	0	6	0	5	0	5	0	6	0	5	0
-20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-30.	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	5	0	5	0	5	0	4	0	5	0	5	0	4	0	4	0
-40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50.	5	0	4	0	5	0	4	0	4	0	5	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	5	0	5	0	5	0	5	0	5	0
-60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70.	6	0	5	0	5	0	6	0	5	0	5	0	5	0	5	0	5	0	6	0	5	0	5	0	5	0	6	0	5	0	5	0	5	0	6	0
-80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90.	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0

TABLE XXIX (Continued)

LAT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
						NUMBER OF SATELLITES										
PROBABILITY (IN PERCENT) OF SEEING EXACTLY N SATELLITES																
90.	0.00	0.00	0.00	0.00	0.00	37.84	35.14	27.03	0.00							
80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
70	0.00	0.00	0.00	0.00	2.10	36.94	38.14	19.07	3.75							
60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
50.	0.00	0.00	0.00	.15	15.32	49.25	31.53	3.75	0.00							
40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
30	0.00	0.00	0.00	0.00	17.12	43.39	32.28	7.21	0.00							
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
10	0.00	0.00	0.00	0.00	1.65	23.12	47.75	26.43	1.05							
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-10	0.00	0.00	0.00	0.00	1.35	20.57	51.95	25.23	.90							
-20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-30.	0.00	0.00	0.00	0.00	4.50	37.54	47.15	10.81	0.00							
-40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-50.	0.00	0.00	0.00	0.00	.90	35.44	53.15	10.51	0.00							
-60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-70.	0.00	0.00	0.00	0.00	0.00	3.00	55.56	27.63	13.81							
-80.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-90.	0.00	0.00	0.00	0.00	0.00	0.00	54.05	13.51	32.43							
PROBABILITY (IN PERCENT) OF SEEING N OR MORE SATELLITES																
90.	100.00	100.00	100.00	100.00	100.00	100.00	62.16	27.03	0.00							
80.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
70.	100.00	100.00	100.00	100.00	100.00	97.90	60.96	22.82	3.75							
60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
50	100.00	100.00	100.00	100.00	99.85	84.53	35.29	3.75	0.00							
40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
30.	100.00	100.00	100.00	100.00	100.00	82.88	39.49	7.21	0.00							
20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
10.	100.00	100.00	100.00	100.00	100.00	98.35	75.23	27.48	1.05							
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-10.	100.00	100.00	100.00	100.00	100.00	98.65	78.08	26.13	.90							
-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-30	100.00	100.00	100.00	100.00	100.00	95.50	57.96	10.81	0.00							
-40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-50.	100.00	100.00	100.00	100.00	100.00	99.10	63.66	10.51	0.00							
-60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-70	100.00	100.00	100.00	100.00	100.00	100.00	97.00	41.44	13.81							
-80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-90	100.00	100.00	100.00	100.00	100.00	100.00	100.00	45.95	32.43							

ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT EXACTLY N SATELLITES WILL BE SEEN

	0	1	2	3	4	5	6	7	8
PROB	0.00	0.00	0.00	.02	5.79	31.95	44.69	16.15	1.40

ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT N OR MORE SATELLITES WILL BE SEEN

	0	1	2	3	4	5	6	7	8
PROB	100.00	100.00	100.00	100.00	99.98	94.20	62.24	17.55	1.40

TABLE XXX

Modified 16 - Best Case

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
1	.070	0.00	30.00	55.00	126.60	12.00
2	.070	0.00	30.00	55.00	233.40	12.00
3	.070	0.00	90.00	55.00	42.80	12.00
4	.070	0.00	90.00	55.00	269.50	12.00
5	.070	0.00	150.00	55.00	83.80	12.00
6	.070	0.00	150.00	55.00	193.90	12.00
7	.070	0.00	150.00	55.00	310.00	12.00
8	.070	0.00	210.00	55.00	123.30	12.00
9	.070	0.00	210.00	55.00	230.00	12.00
10	.070	0.00	210.00	55.00	355.70	12.00
11	.070	0.00	270.00	55.00	161.40	12.00
12	.070	0.00	270.00	55.00	270.60	12.00
13	.070	0.00	270.00	55.00	44.10	12.00
14	.070	0.00	330.00	55.00	198.60	12.00
15	.070	0.00	330.00	55.00	315.90	12.00
16	.070	0.00	330.00	55.00	89.40	12.00

GLOBAL DISTRIBUTION CALCULATIONS

MASKING ANGLE = 5.00 DEGREES
LATITUDE STEP = 10.00 DEGREES
LATITUDE INCREMENT = 2
LONGITUDE INCREMENT = 2
DILUTION OF PRECISION PARAMETERS PRINTED AT TIME INCREMENT OF 0

TOTAL TIME(MIN) = 360
TIME INCREMENT(MIN) = 10

THE SATELLITE MOST NEARLY OVERHEAD IS USED AS ONE OF THE FOUR
IN ALL CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON

TABLE XXX (Continued)

DILUTION OF PRECISION PARAMETERS - ACCUMULATIVE GLOBAL DISTRIBUTION

NUMBER	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP
0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.8	1.0000	1.0000	1.0000	.9780	1.0000	1.0000
1.0	1.0000	1.0000	.8885	.8074	1.0000	1.0000
1.2	1.0000	.9880	.5533	.5726	1.0000	1.0000
1.4	.9975	.7279	.3092	.4247	1.0000	1.0000
1.6	.9554	.4570	.1672	.3375	1.0000	1.0000
1.8	.8511	.2524	.1076	.2702	1.0000	1.0000
2.0	.6879	.1505	.0782	.2055	.9928	.9993
2.2	.5262	.0995	.0612	.1656	.9456	.9876
2.4	.4189	.0731	.0478	.1267	.7922	.9354
2.6	.3429	.0552	.0375	.0939	.6176	.7973
2.8	.2738	.0437	.0313	.0753	.4699	.6440
3.0	.2335	.0362	.0262	.0583	.3762	.5231
3.2	.1959	.0294	.0237	.0510	.3094	.4293
3.4	.1655	.0257	.0218	.0438	.2560	.3856
3.6	.1396	.0234	.0195	.0391	.2161	.3137
3.8	.1190	.0209	.0181	.0348	.1827	.2713
4.0	.0978	.0200	.0174	.0321	.1594	.2294
4.2	.0841	.0187	.0162	.0302	.1313	.2000
4.4	.0710	.0179	.0154	.0286	.1101	.1800
4.6	.0632	.0165	.0145	.0262	.0929	.1583
4.8	.0562	.0158	.0133	.0228	.0776	.1334
5.0	.0522	.0148	.0125	.0222	.0680	.1143
5.2	.0481	.0139	.0117	.0212	.0619	.0971
5.4	.0443	.0137	.0116	.0201	.0577	.0855
5.6	.0416	.0129	.0109	.0192	.0519	.0744
5.8	.0381	.0123	.0107	.0180	.0487	.0666
6.0	.0362	.0120	.0105	.0168	.0455	.0620
6.2	.0344	.0113	.0103	.0149	.0427	.0580
6.4	.0323	.0113	.0101	.0146	.0397	.0547
6.6	.0296	.0107	.0097	.0146	.0376	.0503
6.8	.0280	.0101	.0095	.0143	.0357	.0470
7.0	.0271	.0097	.0087	.0138	.0329	.0438

TABLE XXX (Continued)

MAXIMUM AND MINIMUM NUMBERS SEEN AT EACH LATITUDE & LONGITUDE

MAXIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0
80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	8	0	8	0	8	0	7	0
60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	6	0	6	0	6	0	6	0	5	0	6	0	6	0	6	0	6	0	6	0	6	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0
40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	6	0	6	0	5	0	6	0	6	0	6	0	6	0	7	0	7	0	7	0	7	0	6	0	6	0	7	0	7	0	6	0	6	0	7	0
20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	8	0	7	0	7	0	7	0	7	0	7	0	7	0
0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10.	7	0	6	0	6	0	7	0	7	0	6	0	7	0	8	0	8	0	7	0	7	0	7	0	7	0	7	0	6	0	6	0	6	0	7	0
-20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-30.	6	0	6	0	7	0	6	0	7	0	7	0	7	0	6	0	7	0	7	0	7	0	7	0	7	0	6	0	6	0	6	0	6	0	6	0
-40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50.	7	0	6	0	6	0	7	0	6	0	7	0	7	0	7	0	7	0	6	0	6	0	7	0	6	0	6	0	6	0	6	0	6	0	6	0
-60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70.	7	0	7	0	7	0	8	0	8	0	8	0	8	0	8	0	7	0	8	0	8	0	8	0	7	0	7	0	7	0	7	0	7	0	7	0
-80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90.	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0

MINIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	4	0	5	0	5	0	4	0	4	0	4	0	5	0	4	0	4	0	5	0	5	0	4	0	4	0	4	0	4	0	5	0	4	0	4	0
60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	4	0	4	0	4	0	4	0	4	0	4	0	4	0	3	0	4	0	4	0	4	0	4	0	4	0	5	0	3	0	4	0	4	0	4	0
40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0
20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	5	0	5	0	5	0	5	0	4	0	4	0	5	0	5	0	5	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	4	0
0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10.	4	0	5	0	4	0	5	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	5	0	5	0	5	0	4	0	4	0	5	0	5	0
-20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-30.	3	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	3	0	4	0	4	0	4	0	3	0
-40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50.	4	0	4	0	4	0	4	0	4	0	5	0	5	0	5	0	4	0	4	0	4	0	4	0	3	0	4	0	4	0	4	0	4	0	4	0
-60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70.	5	0	4	0	4	0	5	0	5	0	5	0	5	0	4	0	4	0	5	0	4	0	4	0	4	0	5	0	4	0	4	0	4	0	5	0
-80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90.	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0

TABLE XXX (Continued)

LAT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	NUMBER OF SATELLITES															
PROBABILITY (IN PERCENT) OF SEEING EXACTLY N SATELLITES																
90.	0.00	0.00	0.00	0.00	0.00	37.84	35.14	27.03	0.00							
80.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
70	0.00	0.00	0.00	0.00	2.10	38.14	38.59	19.22	1.95							
60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
50.	0.00	0.00	0.00	.30	16.82	53.75	26.88	2.25	0.00							
40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
30.	0.00	0.00	0.00	0.00	21.17	49.40	25.23	4.20	0.00							
20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
10	0.00	0.00	0.00	0.00	3.45	34.23	51.20	10.81	.30							
0.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-10.	0.00	0.00	0.00	0.00	3.90	37.54	49.25	9.01	.30							
-20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-30.	0.00	0.00	0.00	.45	18.62	48.65	28.53	3.75	0.00							
-40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-50.	0.00	0.00	0.00	.15	16.22	51.35	30.03	2.25	0.00							
-60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-70.	0.00	0.00	0.00	0.00	1.95	34.53	42.79	18.32	2.40							
-80.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-90.	0.00	0.00	0.00	0.00	0.00	37.84	24.32	32.43	5.41							
PROBABILITY (IN PERCENT) OF SEEING N OR MORE SATELLITES																
90.	100.00	100.00	100.00	100.00	100.00	100.00	62.16	27.03	0.00							
80.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
70.	100.00	100.00	100.00	100.00	100.00	97.90	59.76	21.17	1.95							
60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
50.	100.00	100.00	100.00	100.00	99.70	82.88	29.13	2.25	0.00							
40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
30.	100.00	100.00	100.00	100.00	100.00	78.83	29.43	4.20	0.00							
20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
10.	100.00	100.00	100.00	100.00	100.00	96.55	62.31	11.11	.30							
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-10.	100.00	100.00	100.00	100.00	100.00	96.10	58.56	9.31	.30							
-20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-30.	100.00	100.00	100.00	100.00	99.55	80.93	32.28	3.75	0.00							
-40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-50.	100.00	100.00	100.00	100.00	99.85	83.63	32.28	2.25	0.00							
-60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-70	100.00	100.00	100.00	100.00	100.00	98.05	63.51	20.72	2.40							
-80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-90	100.00	100.00	100.00	100.00	100.00	100.00	62.16	37.84	5.41							
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT EXACTLY N SATELLITES WILL BE SEEN																
PROB	0.00	0.00	0.00	.12	11.34	43.73	37.01	7.43	.37							
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT N OR MORE SATELLITES WILL BE SEEN																
PROB	100.00	100.00	100.00	100.00	99.88	88.54	44.81	7.80	.37							

TABLE XXXI
Modified 16 - Worst Case

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
1	.070	0.00	30.00	55.00	126.80	12.00
2	.070	0.00	30.00	55.00	233.40	12.00
3	.070	0.00	90.00	55.00	42.80	12.00
4	.070	0.00	90.00	55.00	160.30	12.00
5	.070	0.00	90.00	55.00	269.50	12.00
6	.070	0.00	150.00	55.00	83.80	12.00
7	.070	0.00	150.00	55.00	193.90	12.00
8	.070	0.00	150.00	55.00	310.00	12.00
9	.070	0.00	210.00	55.00	230.00	12.00
10	.070	0.00	210.00	55.00	355.70	12.00
11	.070	0.00	270.00	55.00	161.40	12.00
12	.070	0.00	270.00	55.00	270.60	12.00
13	.070	0.00	270.00	55.00	44.10	12.00
14	.070	0.00	330.00	55.00	198.60	12.00
15	.070	0.00	330.00	55.00	315.90	12.00
16	.070	0.00	330.00	55.00	89.40	12.00

GLOBAL DISTRIBUTION CALCULATIONS

MASKING ANGLE = 5.00 DEGREES
LATITUDE STEP = 10.00 DEGREES
LATITUDE INCREMENT = 2
LONGITUDE INCREMENT = 2
DILUTION OF PRECISION PARAMETERS PRINTED AT TIME INCREMENT OF 0

TOTAL TIME(MIN) = 360
TIME INCREMENT(MIN) = 10

THE SATELLITE MOST NEARLY OVERHEAD IS USED AS ONE OF THE FOUR
IN ALL CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON

TABLE XXXI (Continued)

DILUTION OF PRECISION PARAMETERS - ACCUMULATIVE GLOBAL DISTRIBUTION

NUMBER	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP
0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.8	1.0000	1.0000	1.0000	.9758	1.0000	1.0000
1.0	1.0000	1.0000	.8839	.8036	1.0000	1.0000
1.2	1.0000	.9879	.5424	.5706	1.0000	1.0000
1.4	.9977	.7225	.3207	.4301	1.0000	1.0000
1.6	.9510	.4598	.1981	.3538	1.0000	1.0000
1.8	.8529	.2744	.1396	.2850	1.0000	1.0000
2.0	.6875	.1808	.1084	.2234	.9915	.9991
2.2	.5292	.1323	.0927	.1804	.9371	.9856
2.4	.4288	.1063	.0786	.1428	.7749	.9292
2.6	.3534	.0853	.0707	.1141	.6070	.7833
2.8	.2850	.0753	.0641	.0968	.4805	.6370
3.0	.2449	.0690	.0589	.0820	.3925	.5240
3.2	.2117	.0632	.0546	.0757	.3270	.4429
3.4	.1846	.0572	.0514	.0711	.2739	.3833
3.6	.1611	.0537	.0497	.0666	.2339	.3318
3.8	.1405	.0515	.0479	.0626	.2043	.2879
4.0	.1207	.0501	.0475	.0603	.1780	.2479
4.2	1056	.0489	.0460	.0577	.1546	.2173
4.4	.0968	.0483	.0451	.0561	.1326	.1968
4.6	.0901	.0464	.0438	.0549	.1170	.1788
4.8	.0840	.0454	.0419	.0533	.1038	.1540
5.0	.0802	.0439	.0412	.0530	.0951	.1361
5.2	.0776	.0428	.0405	.0517	.0905	.1202
5.4	.0758	.0420	.0396	.0496	.0869	.1082
5.6	.0724	.0409	.0391	.0482	.0831	.1004
5.8	.0695	.0402	.0383	.0477	.0806	.0948
6.0	.0674	.0398	.0381	.0462	.0774	.0895
6.2	.0653	.0392	.0375	.0448	.0742	.0852
6.4	.0630	.0388	.0370	.0446	.0697	.0825
6.6	.0625	.0374	.0366	.0438	.0675	.0793
6.8	.0609	.0369	.0364	.0429	.0670	.0763
7.0	.0585	.0368	.0353	.0425	.0661	.0736

TABLE XXXI (Continued)

MAXIMUM AND MINIMUM NUMBERS SEEN AT EACH LATITUDE & LONGITUDE

MAXIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0
80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	8	0	8	0	8	0	7	0
60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	6	0	6	0	6	0	6	0	5	0	6	0	6	0	6	0	6	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0
40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	7	0	7	0	5	0	5	0	6	0	6	0	6	0	7	0	7	0	7	0	7	0	6	0	7	0	7	0	7	0	6	0	6	0	6	0
20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	7	0	6	0	6	0	6	0	7	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0	7	0	7	0	8	0	7	0
0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10.	7	0	6	0	5	0	6	0	6	0	6	0	7	0	8	0	8	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0	6	0	7	0
-20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-30.	6	0	6	0	6	0	5	0	7	0	7	0	7	0	6	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0	6	0	5	0
-40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50.	6	0	6	0	6	0	7	0	6	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0	6	0	7	0	6	0
-60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70.	7	0	7	0	7	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	7	0
-80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90.	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0

MINIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	4	0	4	0	4	0	4	0	4	0	4	0	5	0	4	0	4	0	5	0	5	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0
60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	3	0	3	0	3	0	3	0	3	0	4	0	4	0	3	0	4	0	4	0	4	0	4	0	5	0	5	0	3	0	4	0	3	0	3	0
40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	3	0	3	0	3	0	3	0	3	0	4	0	4	0	4	0	4	0	4	0	4	0	5	0	5	0	5	0	4	0	4	0	3	0	3	0
20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	4	0	4	0	4	0	4	0	4	0	4	0	5	0	5	0	5	0	4	0	5	0	6	0	5	0	5	0	5	0	5	0	4	0	3	0
0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10.	3	0	4	0	4	0	4	0	5	0	4	0	4	0	4	0	5	0	5	0	5	0	5	0	6	0	6	0	5	0	4	0	5	0	4	0
-20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-30.	3	0	4	0	4	0	4	0	3	0	3	0	3	0	3	0	4	0	4	0	5	0	5	0	5	0	4	0	4	0	4	0	4	0	3	0
-40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50.	4	0	4	0	4	0	3	0	3	0	4	0	4	0	4	0	4	0	4	0	5	0	5	0	4	0	4	0	4	0	4	0	4	0	4	0
-60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70.	5	0	4	0	4	0	5	0	5	0	5	0	5	0	4	0	4	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	4	0	5	0
-80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90.	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0

TABLE XXXI (Continued)

NUMBER OF SATELLITES

LAT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PROBABILITY (IN PERCENT) OF SEEING EXACTLY N SATELLITES																
90.	0.00	0.00	0.00	0.00	0.00	54.05	24.32	21.62	0.00							
80.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
70.	0.00	0.00	0.00	0.00	8.71	36.49	38.89	13.96	1.95							
60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
50.	0.00	0.00	0.00	3.75	24.47	41.44	26.88	3.45	0.00							
40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
30.	0.00	0.00	0.00	6.46	19.82	42.64	24.92	6.16	0.00							
20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
10	0.00	0.00	0.00	.45	8.56	32.88	39.79	17.72	.60							
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-10	0.00	0.00	0.00	.30	7.96	35.58	39.49	16.07	.60							
-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-30	0.00	0.00	0.00	1.80	16.82	44.59	30.03	6.76	0.00							
-40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-50	0.00	0.00	0.00	.30	15.02	44.89	34.08	5.71	0.00							
-60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-70	0.00	0.00	0.00	0.00	1.05	28.08	43.84	21.32	5.71							
-80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-90.	0.00	0.00	0.00	0.00	0.00	24.32	37.84	24.32	13.51							
PROBABILITY (IN PERCENT) OF SEEING N OR MORE SATELLITES																
90.	100.00	100.00	100.00	100.00	100.00	100.00	45.95	21.62	0.00							
80.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
70.	100.00	100.00	100.00	100.00	100.00	91.29	54.80	15.92	1.95							
60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
50	100.00	100.00	100.00	100.00	96.25	71.77	30.33	3.45	0.00							
40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
30.	100.00	100.00	100.00	100.00	93.54	73.72	31.08	6.16	0.00							
20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
10.	100.00	100.00	100.00	100.00	99.55	90.99	58.11	18.32	.60							
0.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-10.	100.00	100.00	100.00	100.00	99.70	91.74	56.16	16.67	.60							
-20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-30	100.00	100.00	100.00	100.00	98.20	81.38	36.79	6.76	0.00							
-40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-50.	100.00	100.00	100.00	100.00	99.70	84.68	39.79	5.71	0.00							
-60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-70	100.00	100.00	100.00	100.00	100.00	98.95	70.87	27.03	5.71							
-80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-90	100.00	100.00	100.00	100.00	100.00	100.00	75.68	37.84	13.51							
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT EXACTLY N SATELLITES WILL BE SEEN																
PROB	0.00	0.00	0.00	1.85	13.53	38.89	34.06	11.00	.67							
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT N OR MORE SATELLITES WILL BE SEEN																
PROB	100.00	100.00	100.00	100.00	98.15	84.82	45.73	11.67	.67							

TABLE XXXII
Modified 15 - Best Case

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
1	.070	0.00	30.00	55.00	0.00	12.00
2	.070	0.00	30.00	55.00	126.60	12.00
3	.070	0.00	30.00	55.00	233.40	12.00
4	.070	0.00	150.00	55.00	83.80	12.00
5	.070	0.00	150.00	55.00	193.90	12.00
6	.070	0.00	150.00	55.00	310.00	12.00
7	.070	0.00	210.00	55.00	123.30	12.00
8	.070	0.00	210.00	55.00	230.00	12.00
9	.070	0.00	210.00	55.00	355.70	12.00
10	.070	0.00	270.00	59.00	161.40	12.00
11	.070	0.00	270.00	55.00	270.60	12.00
12	.070	0.00	270.00	55.00	44.10	12.00
13	.070	0.00	330.00	55.00	198.60	12.00
14	.070	0.00	330.00	55.00	315.90	12.00
15	.070	0.00	330.00	55.00	89.40	12.00

GLOBAL DISTRIBUTION CALCULATIONS

MASKING ANGLE = 5.00 DEGREES
LATITUDE STEP = 10.00 DEGREES
LATITUDE INCREMENT = 2
LONGITUDE INCREMENT = 2
DILUTION OF PRECISION PARAMETERS PRINTED AT TIME INCREMENT OF 0

TOTAL TIME(MIN) = 360
TIME INCREMENT(MIN) = 10

THE SATELLITE MOST NEARLY OVERHEAD IS USED AS ONE OF THE FOUR
IN ALL CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON

TABLE XXXII (Continued)

DILUTION OF PRECISION PARAMETERS - ACCUMULATIVE GLOBAL DISTRIBUTION

NUMBER	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP
0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.8	1.0000	1.0000	1.0000	.9818	1.0000	1.0000
1.0	1.0000	1.0000	.8912	.8335	1.0000	1.0000
1.2	1.0000	.9882	.6042	.6152	1.0000	1.0000
1.4	.9977	.7570	.3794	.4656	1.0000	1.0000
1.6	.9637	.5209	.2249	.3775	1.0000	1.0000
1.8	.8695	.3193	.1493	.3151	1.0000	1.0000
2.0	.7261	.2008	.1168	.2558	.9937	.9995
2.2	.5708	.1380	.0919	.2120	.9589	.9897
2.4	.4686	.1066	.0788	.1725	.8365	.9522
2.6	.3970	.0875	.0646	.1322	.6851	.8386
2.8	.3266	.0756	.0569	.1140	.5302	.7055
3.0	.2840	.0630	.0502	.0960	.4318	.5885
3.2	.2522	.0547	.0454	.0840	.3618	.4823
3.4	.2181	.0492	.0427	.0757	.3117	.4137
3.6	.1915	.0459	.0391	.0692	.2734	.3636
3.8	.1653	.0420	.0378	.0633	.2393	.3259
4.0	.1425	.0413	.0363	.0561	.2129	.2851
4.2	.1284	.0392	.0348	.0526	.1831	.2523
4.4	.1124	.0375	.0332	.0498	.1591	.2330
4.6	.1030	.0354	.0312	.0455	.1392	.2112
4.8	.0951	.0333	.0307	.0404	.1219	.1848
5.0	.0871	.0324	.0293	.0391	.1113	.1604
5.2	.0812	.0306	.0283	.0381	.1025	.1440
5.4	.0761	.0296	.0270	.0360	.0964	.1296
5.6	.0729	.0291	.0262	.0352	.0893	.1180
5.8	.0686	.0283	.0251	.0338	.0854	.1069
6.0	.0648	.0279	.0245	.0328	.0811	.1008
6.2	.0598	.0265	.0242	.0303	.0768	.0960
6.4	.0570	.0259	.0232	.0292	.0722	.0927
6.6	.0533	.0254	.0227	.0292	.0671	.0869
6.8	.0500	.0249	.0226	.0287	.0630	.0833
7.0	.0485	.0245	.0216	.0279	.0574	.0791

TABLE XXXII (Continued)

MAXIMUM AND MINIMUM NUMBERS SEEN AT EACH LATITUDE & LONGITUDE

MAXIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0
80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C	0	0	0	0	0	0	0	0
70.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0
60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	7	0	6	0	6	0	6	0	5	0	6	0	6	0	5	0	5	0	6	0	6	0	6	0	6	0	6	0	6	0	7	0	6	0	6	0
40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	6	0	6	0	5	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	5	0	5	0	6	0	7	0	6	0	6	0	7	0
20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	6	0	7	0	7	0	6	0	7	0	7	0	6	0	6	0	6	0	6	0	6	0	7	0	6	0	6	0	7	0	7	0	7	0	7	0
0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10.	7	0	6	0	6	0	7	0	7	0	6	0	7	0	7	0	7	0	7	0	6	0	6	0	7	0	6	0	6	0	6	0	6	0	6	0
-20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-30.	6	0	6	0	6	0	6	0	6	0	7	0	7	0	6	0	7	0	7	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0
-40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50.	6	0	6	0	6	0	6	0	6	0	7	0	6	0	6	0	7	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0
-60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0
-80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0

MINIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	4	0	4	0	5	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	5	0	4	0	4	0	5	0
60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	4	0	4	0	4	0	4	0	4	0	4	0	3	0	3	0	4	0	4	0	3	0	3	0	4	0	4	0	3	0	4	0	5	0	4	0
40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	4	0	4	0	4	0	4	0	4	0	4	0	4	0	3	0	3	0	4	0	3	0	3	0	4	0	4	0	4	0	4	0	5	0	4	0
20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	4	0	5	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	4	0	4	0	5	0	4	0	4	0	5	0	5	0	4	0	5	0
0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10.	4	0	4	0	4	0	5	0	5	0	4	0	5	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0
-20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-30.	3	0	4	0	4	0	3	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	3	0	3	0	4	0	3	0	3	0	3	0
-40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50.	4	0	4	0	4	0	4	0	4	0	4	0	4	0	5	0	3	0	3	0	4	0	4	0	3	0	4	0	3	0	4	0	4	0	3	0
-60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70.	5	0	4	0	4	0	5	0	4	0	5	0	5	0	4	0	4	0	5	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0
-80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90.	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0

TABLE XXXII (Continued)

NUMBER OF SATELLITES

LAT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

PROBABILITY (IN PERCENT) OF SEEING EXACTLY N SATELLITES

LAT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
90.	0.00	0.00	0.00	0.00	0.00	62.18	24.32	13.51								
80.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
70.	0.00	0.00	0.00	0.00	3.90	58.46	27.48	12.16								
60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
50.	0.00	0.00	0.00	1.05	32.28	49.10	17.12	.45								
40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
30.	0.00	0.00	0.00	1.50	34.38	46.10	17.27	.75								
20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
10.	0.00	0.00	0.00	0.00	7.21	52.25	38.89	1.65								
0.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
-10.	0.00	0.00	0.00	0.00	8.56	53.60	36.64	1.20								
-20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
-30.	0.00	0.00	0.00	1.95	32.13	46.25	18.62	1.05								
-40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
-50.	0.00	0.00	0.00	1.05	31.38	51.65	15.32	.60								
-60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
-70.	0.00	0.00	0.00	0.00	3.30	61.11	25.68	9.91								
-80.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
-90.	0.00	0.00	0.00	0.00	0.00	54.05	29.73	16.22								

PROBABILITY (IN PERCENT) OF SEEING N OR MORE SATELLITES

LAT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
90.	100.00	100.00	100.00	100.00	100.00	100.00	37.84	13.51								
80.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
70	100.00	100.00	100.00	100.00	100.00	96.10	39.64	12.16								
60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
50	100.00	100.00	100.00	100.00	98.95	66.67	17.57	.45								
40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
30.	100.00	100.00	100.00	100.00	98.50	64.11	18.02	.75								
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
10.	100.00	100.00	100.00	100.00	100.00	92.79	40.54	1.65								
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
-10	100.00	100.00	100.00	100.00	100.00	91.44	37.84	1.20								
-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
-30	100.00	100.00	100.00	100.00	98.05	65.92	19.67	1.05								
-40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
-50	100.00	100.00	100.00	100.00	98.95	67.57	15.92	.60								
-60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
-70	100.00	100.00	100.00	100.00	100.00	96.70	35.59	9.91								
-80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
-90.	100.00	100.00	100.00	100.00	100.00	100.00	45.95	16.22								

ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT EXACTLY N SATELLITES WILL BE SEEN

	0	1	2	3	4	5	6	7
PROB	0.00	0.00	0.00	.77	20.55	50.99	25.48	2.22

ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT N OR MORE SATELLITES WILL BE SEEN

	0	1	2	3	4	5	6	7
PROB	100.00	100.00	100.00	100.00	99.23	78.69	27.70	2.22

TABLE XXXIII
Modified 15 - Worst Case

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
1	.070	0.00	30.00	55.00	126.60	12.00
2	.070	0.00	30.00	55 00	233.40	12.00
3	.070	0.00	90.00	55.00	42.80	12.00
4	.070	0.00	90.00	55.00	160.30	12.00
5	.070	0.00	90.00	55.00	269.50	12.00
6	.070	0.00	150.00	55.00	83.80	12.00
7	.070	0.00	150.00	55.00	310.00	12.00
8	.070	0.00	210.00	55.00	123.30	12.00
9	.070	0.00	210.00	55.00	230.00	12.00
10	.070	0.00	210.00	55.00	355.70	12.00
11	.070	0.00	270.00	55.00	161.40	12.00
12	.070	0.00	270.00	55.00	270.60	12.00
13	.070	0.00	330.00	55.00	198.60	12.00
14	.070	0.00	330.00	55.00	315.90	12.00
15	.070	0.00	330.00	55.00	89.40	12.00

GLOBAL DISTRIBUTION CALCULATIONS

MASKING ANGLE = 5.00 DEGREES
LATITUDE STEP = 10.00 DEGREES
LATITUDE INCREMENT = 2
LONGITUDE INCREMENT = 2
DILUTION OF PRECISION PARAMETERS PRINTED AT TIME INCREMENT OF 0

TOTAL TIME(MIN) = 360
TIME INCREMENT(MIN) = 10

THE SATELLITE MOST NEARLY OVERHEAD IS USED AS ONE OF THE FOUR
IN ALL CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON

TABLE XXXIII (Continued)

DILUTION OF PRECISION PARAMETERS - ACCUMULATIVE GLOBAL DISTRIBUTION

NUMBER	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP
0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.8	1.0000	1.0000	1.0000	.9811	1.0000	1.0000
1.0	1.0000	1.0000	.8985	.8355	1.0000	1.0000
1.2	1.0000	.9866	.5957	.6341	1.0000	1.0000
1.4	.9987	.7534	.3880	.5074	1.0000	1.0000
1.6	.9615	.5255	.2744	.4284	1.0000	1.0000
1.8	.8801	.3455	.2205	.3693	1.0000	1.0000
2.0	.7348	.2607	.1884	.3166	.9939	.9993
2.2	.5956	.2156	.1696	.2765	.9521	.9893
2.4	.5084	.1878	.1548	.2347	.8111	.9427
2.6	.4435	.1679	.1426	.2030	.6682	.8152
2.8	.3826	.1504	.1348	.1811	.5480	.6915
3.0	.3421	.1394	.1282	.1631	.4753	.5924
3.2	.3082	.1325	.1227	.1506	.4167	.5166
3.4	.2769	.1260	.1176	.1440	.3700	.4658
3.6	.2511	.1223	.1152	.1374	.3352	.4197
3.8	.2306	.1179	.1115	.1310	.3019	.3790
4.0	.2132	.1157	.1080	.1262	.2730	.3464
4.2	.1949	.1121	.1073	.1234	.2480	.3177
4.4	.1812	.1103	.1062	.1201	.2296	.2968
4.6	.1715	.1086	.1034	.1170	.2111	.2729
4.8	.1624	.1062	.1012	.1143	.1964	.2500
5.0	.1568	.1043	.1008	.1125	.1820	.2312
5.2	1523	.1029	.0986	.1094	.1722	.2150
5.4	.1498	.1019	.0967	.1081	.1660	.2008
5.6	.1460	.0994	.0960	.1059	.1607	.1869
5.8	.1419	.0984	.0948	.1037	.1570	.1771
6.0	.1387	.0974	.0939	.1029	.1530	.1709
6.2	.1364	.0958	.0934	.1008	.1496	.1658
6.4	.1320	.0951	.0928	.1004	.1456	.1618
6.6	.1290	.0943	.0917	.0992	.1407	.1582
6.8	.1265	.0934	.0909	.0990	.1376	.1532
7.0	.1250	.0917	.0896	.0988	.1349	.1495

TABLE XXXIII (Continued)

MAXIMUM AND MINIMUM NUMBERS SEEN AT EACH LATITUDE & LONGITUDE

MAXIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0
80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	7	0	6	0	6	0	6	0	6	0	6	0	6	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	8	0	8	0	8	0	7	0
60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	5	0	5	0	5	0	5	0	5	0	6	0	6	0	6	0	6	0	7	0	6	0	7	0	7	0	7	0	7	0	6	0	6	0	5	0
40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	6	0	5	0	4	0	5	0	5	0	5	0	6	0	7	0	7	0	7	0	7	0	6	0	7	0	7	0	7	0	6	0	6	0	6	0
20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	6	0	5	0	5	0	7	0	6	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0	7	0	7	0	7	0	6	0
0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10.	6	0	5	0	5	0	6	0	6	0	6	0	7	0	8	0	8	0	7	0	7	0	7	0	8	0	8	0	7	0	7	0	6	0	6	0
-20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-30.	5	0	5	0	5	0	5	0	6	0	7	0	7	0	6	0	7	0	7	0	7	0	7	0	7	0	6	0	7	0	7	0	6	0	5	0
-40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50.	6	0	5	0	6	0	6	0	6	0	6	0	6	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	6	0	6	0	6	0
-60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	8	0	8	0	8	0	8	0	8	0	7	0	7	0	7	0	7	0
-80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90.	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0

MINIMUM

LONGITUDE

LAT	0					50					100					150					200					250					300					350
90.	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0
80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.	3	0	4	0	4	0	3	0	3	0	4	0	4	0	4	0	4	0	4	0	4	0	3	0	3	0	3	0	4	0	4	0	3	0	3	0
60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.	3	0	3	0	3	0	3	0	3	0	3	0	4	0	3	0	4	0	4	0	4	0	4	0	4	0	4	0	3	0	3	0	3	0	3	0
40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	2	0	3	0	2	0	2	0	3	0	3	0	3	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	3	0	2	0
20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	3	0	3	0	4	0	3	0	3	0	3	0	4	0	5	0	5	0	4	0	5	0	6	0	5	0	5	0	5	0	5	0	3	0	2	0
0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10.	3	0	3	0	3	0	3	0	4	0	4	0	3	0	4	0	5	0	5	0	5	0	5	0	6	0	5	0	3	0	4	0	4	0	3	0
-20.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-30.	3	0	3	0	3	0	3	0	2	0	3	0	3	0	4	0	4	0	4	0	5	0	5	0	5	0	4	0	4	0	4	0	3	0	3	0
-40.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50.	3	0	3	0	3	0	3	0	2	0	3	0	4	0	4	0	4	0	4	0	5	0	5	0	4	0	4	0	4	0	4	0	4	0	4	0
-60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70.	5	0	4	0	4	0	5	0	5	0	4	0	4	0	5	0	5	0	5	0	4	0	4	0	4	0	5	0	4	0	4	0	5	0	5	0
-80.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90.	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0

TABLE XXXIII (Continued)

LAT	NUMBER OF SATELLITES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PROBABILITY (IN PERCENT) OF SEEING EXACTLY N SATELLITES																
90.	0.00	0.00	0.00	0.00	24.32	37.84	27.03	10.81	0.00							
80.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
70.	0.00	0.00	0.00	1.20	25.68	34.53	30.63	6.01	1.95							
60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
50.	0.00	0.00	0.00	9.91	36.04	35.59	17.12	1.35	0.00							
40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
30.	0.00	0.00	1.20	14.11	27.48	35.14	17.87	4.20	0.00							
20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
10.	0.00	0.00	.45	6.16	19.97	25.08	33.18	14.71	.45							
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-10.	0.00	0.00	0.00	5.11	21.77	25.38	31.68	15.47	.60							
-20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-30.	0.00	0.00	.15	7.81	24.17	36.19	25.83	5.86	0.00							
-40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-50.	0.00	0.00	.15	2.55	24.32	43.39	25.98	3.60	0.00							
-60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-70.	0.00	0.00	0.00	0.00	1.80	41.29	39.94	15.17	1.80							
-80.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-90.	0.00	0.00	0.00	0.00	0.00	37.84	27.03	35.14	0.00							
PROBABILITY (IN PERCENT) OF SEEING N OR MORE SATELLITES																
90.	100.00	100.00	100.00	100.00	100.00	75.68	37.84	10.81	0.00							
80.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
70.	100.00	100.00	100.00	100.00	98.80	73.12	38.59	7.96	1.95							
60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
50	100.00	100.00	100.00	100.00	90.09	54.05	18.47	1.35	0.00							
40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
30.	100.00	100.00	100.00	98.80	84.68	57.21	22.07	4.20	0.00							
20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
10.	100.00	100.00	100.00	99.55	93.39	73.42	48.35	15.17	.45							
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-10	100.00	100.00	100.00	100.00	94.89	73.12	47.75	16.07	.60							
-20.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-30.	100.00	100.00	100.00	99.85	92.04	67.87	31.68	5.86	0.00							
-40.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-50.	100.00	100.00	100.00	99.85	97.30	72.97	29.58	3.60	0.00							
-60.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-70.	100.00	100.00	100.00	100.00	100.00	98.20	56.91	16.97	1.80							
-80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
-90.	100.00	100.00	100.00	100.00	100.00	100.00	62.16	35.14	0.00							
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT EXACTLY N SATELLITES WILL BE SEEN																
PROB	0.00	0.00	.30	6.79	23.63	33.18	27.08	8.62	.41							
ON A GLOBAL BASIS THE PROBABILITY (IN PERCENT) THAT N OR MORE SATELLITES WILL BE SEEN																
PROB	100.00	100.00	100.00	99.70	92.91	69.28	36.10	9.02	.41							

TABLE XXXIV
Geosynchronous User, Antenna BWDTH = 21.4°

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
1	.000	.00	30.00	55.00	.00	12.00
2	.000	.00	30.00	55.00	120.00	12.00
3	.000	.00	30.00	55.00	240.00	12.00
4	.000	.00	90.00	55.00	40.00	12.00
5	.000	.00	90.00	55.00	160.00	12.00
6	.000	.00	90.00	55.00	280.00	12.00
7	.000	.00	150.00	55.00	80.00	12.00
8	.000	.00	150.00	55.00	200.00	12.00
9	.000	.00	150.00	55.00	320.00	12.00
10	.000	.00	210.00	55.00	120.00	12.00
11	.000	.00	210.00	55.00	240.00	12.00
12	.000	.00	210.00	55.00	360.00	12.00
13	.000	.00	270.00	55.00	160.00	12.00
14	.000	.00	270.00	55.00	280.00	12.00
15	.000	.00	270.00	55.00	40.00	12.00
16	.000	.00	330.00	55.00	200.00	12.00
17	.000	.00	330.00	55.00	320.00	12.00
18	.000	.00	330.00	55.00	80.00	12.00

USER SATELLITE ORBITAL ELEMENTS

19	.000	.00	.00	.00	.00	24.00

TOTAL TIME(MIN) = 720
TIME INCREMENT(MIN) = 5
BEAMWIDTH ANGLE(DEG) = 21.40
FRACTION OF NAVSAT SPHERICAL AREA = 1.000

ALL SATELLITES, TAKEN FOUR AT A TIME, ARE USED IN THE CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON

TABLE XXXIV (Continued)

TIME(MN)	ALT(NM)	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP	SATELLITES CHOSEN
0	19364.	ONLY	2 SATELLITES ARE VISIBLE.					
5	19364.	ONLY	2 SATELLITES ARE VISIBLE.					
10	19364	ONLY	2 SATELLITES ARE VISIBLE.					
15	19364.	ONLY	2 SATELLITES ARE VISIBLE.					
20	19364.	ONLY	2 SATELLITES ARE VISIBLE.					
25	19364	ONLY	2 SATELLITES ARE VISIBLE.					
30	19364.	ONLY	2 SATELLITES ARE VISIBLE.					
35	19364.	ONLY	3 SATELLITES ARE VISIBLE.					
40	19364.	ONLY	2 SATELLITES ARE VISIBLE.					
45	19364.	ONLY	1 SATELLITES ARE VISIBLE.					
50	19364	ONLY	1 SATELLITES ARE VISIBLE.					
55	19364	ONLY	1 SATELLITES ARE VISIBLE.					
60	19364	ONLY	1 SATELLITES ARE VISIBLE.					
65	19364	ONLY	0 SATELLITES ARE VISIBLE.					
70	19364.	ONLY	0 SATELLITES ARE VISIBLE.					
75	19364	ONLY	0 SATELLITES ARE VISIBLE.					
80	19364.	ONLY	0 SATELLITES ARE VISIBLE.					
85	19364	ONLY	0 SATELLITES ARE VISIBLE.					
90	19364	ONLY	0 SATELLITES ARE VISIBLE.					
95	19364.	ONLY	0 SATELLITES ARE VISIBLE.					

TABLE XXXIV (Continued)

TIME(MN)	ALT(NM)	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP	SATELLITES CHOSEN
100	19364.	ONLY	0 SATELLITES ARE VISIBLE.					
105	19364.	ONLY	0 SATELLITES ARE VISIBLE.					
110	19364.	ONLY	0 SATELLITES ARE VISIBLE.					
115	19364.	ONLY	0 SATELLITES ARE VISIBLE.					
120	19364.	ONLY	0 SATELLITES ARE VISIBLE.					
125	19364.	ONLY	0 SATELLITES ARE VISIBLE.					
130	19364.	ONLY	0 SATELLITES ARE VISIBLE.					
135	19364.	ONLY	0 SATELLITES ARE VISIBLE.					
140	19364.	ONLY	0 SATELLITES ARE VISIBLE.					
145	19364.	ONLY	0 SATELLITES ARE VISIBLE.					
150	19364.	ONLY	0 SATELLITES ARE VISIBLE.					
155	19364.	ONLY	0 SATELLITES ARE VISIBLE.					
160	19364.	ONLY	0 SATELLITES ARE VISIBLE.					
165	19364.	ONLY	0 SATELLITES ARE VISIBLE.					
170	19364.	ONLY	0 SATELLITES ARE VISIBLE.					
175	19364.	ONLY	0 SATELLITES ARE VISIBLE					
180	19364.	ONLY	1 SATELLITES ARE VISIBLE.					
185	19364.	ONLY	1 SATELLITES ARE VISIBLE.					
190	19364.	ONLY	1 SATELLITES ARE VISIBLE.					
195	19364.	ONLY	1 SATELLITES ARE VISIBLE.					

TABLE XXXIV (Continued)

TIME(MN)	ALT(NM)	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP	SATELLITES CHOSEN
200	19364.	ONLY	2 SATELLITES ARE VISIBLE.					
205	19364.	ONLY	3 SATELLITES ARE VISIBLE.					
210	19364	ONLY	2 SATELLITES ARE VISIBLE.					
215	19364.	ONLY	2 SATELLITES ARE VISIBLE.					
220	19364.	ONLY	2 SATELLITES ARE VISIBLE.					
225	19364	ONLY	2 SATELLITES ARE VISIBLE.					
230	19364.	ONLY	2 SATELLITES ARE VISIBLE.					
235	19384.	ONLY	2 SATELLITES ARE VISIBLE.					
240	19364	ONLY	2 SATELLITES ARE VISIBLE.					
245	19364.	ONLY	2 SATELLITES ARE VISIBLE.					
250	19364.	ONLY	1 SATELLITES ARE VISIBLE.					
255	19364.	ONLY	1 SATELLITES ARE VISIBLE.					
260	19364.	ONLY	1 SATELLITES ARE VISIBLE.					
265	19384	ONLY	1 SATELLITES ARE VISIBLE.					
270	19364	ONLY	1 SATELLITES ARE VISIBLE.					
275	19364	ONLY	1 SATELLITES ARE VISIBLE.					
280	19364.	ONLY	1 SATELLITES ARE VISIBLE.					
285	19364.	ONLY	1 SATELLITES ARE VISIBLE.					
290	19364	ONLY	1 SATELLITES ARE VISIBLE.					
295	19384.	ONLY	1 SATELLITES ARE VISIBLE.					

TABLE XXXV

Geosynchronous User, Antenna Bwdth = 45°

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
1	.000	.00	30.00	55.00	.00	12.00
2	.000	.00	30.00	55.00	120.00	12.00
3	.000	.00	30.00	55.00	240.00	12.00
4	.000	.00	90.00	55.00	40.00	12.00
5	.000	.00	90.00	55.00	160.00	12.00
6	.000	.00	90.00	55.00	280.00	12.00
7	.000	.00	150.00	55.00	80.00	12.00
8	.000	.00	150.00	55.00	200.00	12.00
9	.000	.00	150.00	55.00	320.00	12.00
10	.000	.00	210.00	55.00	120.00	12.00
11	.000	.00	210.00	55.00	240.00	12.00
12	.000	.00	210.00	55.00	360.00	12.00
13	.000	.00	270.00	55.00	160.00	12.00
14	.000	.00	270.00	55.00	280.00	12.00
15	.000	.00	270.00	55.00	40.00	12.00
16	.000	.00	330.00	55.00	200.00	12.00
17	.000	.00	330.00	55.00	320.00	12.00
18	.000	.00	330.00	55.00	80.00	12.00

USER SATELLITE ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
19	.000	.00	.00	.00	.00	24.00

TOTAL TIME(MIN) = 720
TIME INCREMENT(MIN) = 5
BEAMWIDTH ANGLE(DEG) = 45.00
FRACTION OF NAVSAT SPHERICAL AREA = 1.000

ALL SATELLITES, TAKEN FOUR AT A TIME, ARE USED IN
THE CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON

TABLE XXXV (Continued)

TIME(MN	ALT(NM)	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP	SATELLITES CHOSEN
0	19364.	18.861	3.279	2.468	17.668	19.143	26.051	16 4 7 14 2 9 12
5	19364.	18.774	3.334	2.472	18.497	20.053	27.281	18 4 7 14 2 9 12
10	19364	20.960	3.421	2.495	19.583	21.238	28.888	16 4 7 14 2 9 12
15	19364.	20.351	3.310	2.568	18.956	20.618	28.008	4 7 12 14 16 2 9
20	19364.	19.574	3.283	2.517	18.229	19.848	26.949	4 7 12 14 16 2 9
25	19364	19.696	4.173	3.319	18.708	20.133	27.484	16 4 12 14 2 9
30	19364.	20.358	4.109	3.292	19.315	20.769	28.362	16 4 12 14 2 9
35	19384.	21.171	4.058	3.272	20.064	21.556	29.448	16 4 12 14 2 9
40	19364	22.204	3.851	3.103	20.995	22.535	30.800	2 4 9 14 12 16
45	19364.	21.254	3.832	3.038	20.109	21.597	29.509	2 4 9 14 12 16
50	19364.	20.484	3.828	2.986	19.393	20.839	28.466	2 4 9 14 12 16
55	19364	19.871	3.837	2.944	18.825	20.238	27.640	2 4 9 14 12 16
60	19364.	19.396	3.859	2.912	18.389	19.776	27.005	2 4 9 14 12 16
65	19364.	34.293	3.324	2.377	32.274	34.454	47.209	4 9 12 14 16
70	19364	36.828	3.316	2.368	34.661	36.977	50.682	4 9 12 14 16
75	19364.	40.239	3.324	2.429	37.876	40.376	55.360	4 9 12 14 16
80	19364.	44.888	3.356	2.512	42.260	45.013	61.742	4 9 12 14 16
85	19364.	51.479	3.425	2.635	48.477	51.593	70.794	4 9 12 14 16
90	19364	29.843	3.173	2.436	27.812	30.011	40.916	4 9 11 14 16 12
95	19384.	32.780	3.169	2.411	30.577	32.933	44.839	4 9 11 14 16 12

TABLE XXXV (Continued)

TIME(MN)	ALT(NM)	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP	SATELLITES CHOSEN
100	19364.	36.480	3.174	2.393	34.065	36.618	50.013	9 4 11 14 12 16
105	19364.	41.238	3.190	2.383	38.552	41.361	56.542	9 4 11 14 12 16
110	19364.	45.670	3.112	2.404	42.699	45.776	62.600	9 11 12 14 4 16
115	19364.	46.089	2.977	2.241	43.077	46.185	63.156	9 11 12 14 4 16
120	19364.	46.239	2.929	2.182	43.212	46.332	63.355	14 9 11 12 4 16
125	19364.	46.065	2.976	2.240	43.055	46.161	63.124	14 9 11 12 4 16
130	19364.	45.676	3.111	2.403	42.705	45.782	62.608	14 9 11 12 4 16
135	19364.	41.260	3.190	2.383	38.573	41.383	56.572	14 9 12 16 4 11
140	19364	36.480	3.174	2.393	34.065	36.618	50.013	14 9 12 16 4 11
145	19364.	32.789	3.168	2.411	30.586	32.942	44.952	9 12 14 16 4 11
150	19364.	29.857	3.173	2.435	27.825	30.025	40.936	9 12 14 16 4 11
155	19364.	51.473	3.425	2.636	48.471	51.587	70.786	9 11 14 16 4
160	19364.	44.895	3.357	2.513	42.267	45.021	61.752	9 11 14 16 4
165	19364.	40.251	3.324	2.429	37.888	40.388	55.378	9 11 14 16 4
170	19364.	36.843	3.315	2.369	34.676	36.992	50.703	9 11 14 16 4
175	19364.	34.296	3.324	2.377	32.277	34.456	47.212	9 11 14 16 4
180	19364.	19.395	3.860	2.912	18.388	19.775	27.003	2 9 14 16 4 11
185	19364	19.871	3.837	2.944	18.825	20.238	27.639	2 9 14 16 4 11
190	19364.	20.484	3.827	2.985	19.392	20.838	28.466	2 9 14 16 4 11
195	19364.	21.249	3.832	3.038	20.104	21.592	29.502	2 9 14 16 4 11

AD-A151 692 GLOBAL POSITIONING SYSTEM - A MODIFICATION TO THE BASELINE SATELLITE CONS..(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF ENGI.. D W THOMIN 3/3

UNCLASSIFIED DEC 84 AFIT/GA/ENG/84D-4 F/G 17/7 NL

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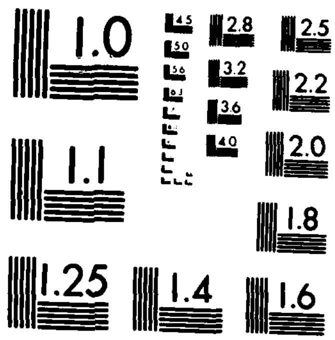

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TABLE XXXV (Continued)

TIME(MN)	ALT(NM)	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP	SATELLITES CHOSEN
200	19364.	22.199	3.851	3.102	20.991	22.531	30.794	2 9 14 16 4 11
205	19364.	21.176	4.056	3.272	20.068	21.561	29.455	4 9 11 16 2 14
210	19364	20 358	4.109	3.291	19.315	20.769	28.362	4 9 11 16 2 14
215	19364.	19.697	4.173	3.319	18.709	20.134	27.485	4 9 11 16 2 14
220	19364.	19.572	3.282	2.516	18.228	19.846	26.946	9 11 13 16 4 2 14
225	19364	20.350	3.310	2.568	18.955	20.617	28.006	9 11 13 16 4 2 14
230	19364.	20 963	3.421	2.495	19.586	21.241	28.892	4 9 13 16 2 11 14
235	19364.	19.776	3.334	2.473	18.499	20.055	27.284	4 9 13 16 2 11 14
240	19364.	18.861	3.279	2.468	17.669	19.144	26.052	4 9 13 16 2 11 14
245	19364	18.170	3.249	2.477	17.049	18.458	25.127	4 9 13 16 2 11 14
250	19364.	27.497	3.822	3.210	25.717	27.761	37.843	11 9 13 16 2 14
255	19364	29.999	4.043	3.463	28.094	30.270	41.298	11 9 13 16 2 14
260	19364	33.133	4.334	3.788	31.073	33.415	45.630	11 9 13 16 2 14
265	19364	37.110	4.721	4.213	34.854	37.409	51.130	11 9 13 16 2 14
270	19364.	40.543	5.626	5.130	38.154	40.932	55.956	11 13 14 16 2 9
275	19364	17 061	2.961	2.103	15.833	17.316	23.463	11 1 2 14 9 13 16
280	19364.	17.311	3.719	2.953	16.044	17.706	23.893	11 1 13 16 2 9
285	19364	17.737	3.773	3.034	16.469	18.133	24.496	11 1 13 16 2 9
290	19364.	24.405	2.882	2.189	22.594	24.574	33.382	1 9 13 16 11 2
295	19364.	23.712	2.934	2.271	21.999	23.893	32.478	1 9 13 16 11 2

TABLE XXXVI
Geosynchronous User, Antenna Bwdth = 90°

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
1	.000	.00	30.00	55.00	.00	12.00
2	.000	.00	30.00	55.00	120.00	12 00
3	.000	.00	30.00	55.00	240.00	12.00
4	.000	.00	90.00	55.00	40.00	12.00
5	.000	.00	90.00	55 00	160.00	12.00
6	.000	.00	90.00	55.00	280.00	12.00
7	.000	.00	150.00	55.00	80.00	12.00
8	.000	.00	150.00	55.00	200.00	12.00
9	.000	.00	150.00	55.00	320.00	12.00
10	.000	.00	210.00	55 00	120.00	12 00
11	.000	.00	210.00	55.00	240.00	12.00
12	.000	.00	210.00	55.00	360.00	12.00
13	.000	.00	270.00	55.00	160.00	12.00
14	.000	.00	270.00	55.00	280.00	12.00
15	000	.00	270.00	55.00	40 00	12.00
16	.000	.00	330.00	55.00	200.00	12.00
17	.000	.00	330.00	55.00	320.00	12.00
18	.000	.00	330.00	55.00	80.00	12.00

USER SATELLITE ORBITAL ELEMENTS

19	.000	.00	.00	.00	.00	24.00

TOTAL TIME(MIN) = 720
TIME INCREMENT(MIN) = 5
BEAMWIDTH ANGLE(DEG) = 90.00
FRACTION OF NAVSAT SPHERICAL AREA = 1.000

ALL SATELLITES, TAKEN FOUR AT A TIME, ARE USED IN
THE CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON

TABLE XXVI (Continued)

TIME(MN)	ALT(NM)	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP	SATELLITES CHOSEN
0	19364.	5.889	2.080	1.733	4.959	6.246	7.975	16 6 15 18 2 3 4 5 7 9 11 12 13 14 17
5	19364.	5.939	2.103	1.754	5.001	6.301	8.045	16 6 15 18 2 3 4 5 7 9 11 12 13 14 17
10	19364	5.997	2.130	1.778	5.051	6.364	8.125	16 6 15 18 2 3 4 5 7 9 11 12 13 14 17
15	19364.	5.947	2.132	1.691	4.983	6.317	8.046	16 6 17 18 2 3 4 5 7 9 11 12 13 14 15
20	19364.	6.000	2.079	1.619	5.028	6.350	8.100	16 6 17 18 2 3 4 5 7 9 11 12 13 14 15
25	19364.	6.059	2.034	1.553	5.078	6.391	8.163	16 6 17 18 2 3 4 5 7 9 11 12 13 14 15
30	19364.	6.122	1.998	1.494	5.131	6.439	8.234	16 6 17 18 2 3 4 5 7 9 11 12 13 14 15
35	19364.	6.189	1.969	1.440	5.187	6.494	8.312	16 6 17 18 2 3 4 5 7 9 11 12 13 14 15
40	19364	6.259	1.947	1.392	5.247	6.555	8.396	6 16 17 18 2 3 4 5 7 9 11 12 13 14 15
45	19364	6.333	1.932	1.384	5.309	6.622	8.487	6 16 17 18 2 3 4 5 7 9 11 12 13 14 15
50	19364	6.411	1.924	1.409	5.373	6.693	8.583	6 16 17 18 2 3 4 5 7 9 11 12 13 14 15
55	19364	6.491	1.922	1.437	5.440	6.769	8.684	6 16 17 18 2 3 4 5 7 9 11 12 13 14 15
60	19364	6.584	2.060	1.649	5.561	6.899	8.862	2 6 17 18 3 4 5 7 9 11 12 13 14 15 16
65	19364	7.498	1.959	1.403	6.369	7.749	10.030	3 12 13 15 16 4 5 6 7 9 11 14 18
70	19364	7.557	1.952	1.422	6.406	7.805	10.097	3 12 13 15 16 4 5 6 7 9 11 14 18
75	19364	7.626	1.947	1.441	6.451	7.871	10.177	3 12 13 15 16 4 5 6 7 9 11 14 18
80	19364.	7.843	2.037	1.608	6.505	8.103	10.391	3 6 9 15 16 4 5 7 11 12 13 14 18
85	19364.	7.758	2.006	1.580	6.420	8.013	10.287	3 6 9 15 16 4 5 7 11 12 13 14 18
90	19364	7.678	1.977	1.555	6.340	7.928	10.151	3 6 9 15 16 4 5 7 11 12 13 14 18
95	19364.	7.603	1.951	1.530	6.265	7.849	10.043	3 6 9 15 16 1 4 5 7 11 12 13 14 18

TABLE XXVI (Continued)

TIME(MN)	ALT(NM)	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP	SATELLITES CHOSEN
100	19364.	7.534	1.928	1.508	6.197	7.777	9.944	9 3 6 15 1 4 5 7 11 12 13 14 16 18
105	19364.	7.470	1.908	1.487	6.133	7.710	9.852	9 3 6 15 1 4 5 7 8 11 12 13 14 16 18
110	19364.	7.404	1.962	1.565	6.185	7.660	9.845	9 1 7 8 3 4 5 11 12 13 14 15 16 18
115	19364.	7.483	1.957	1.554	6.247	7.735	9.943	9 1 7 8 3 4 5 11 12 13 14 15 16 18
120	19364.	7.580	1.953	1.541	6.326	7.827	10.064	14 3 13 15 1 4 5 7 8 9 11 12 16 18
125	19364.	7.483	1.957	1.554	6.247	7.735	9.943	14 3 13 15 1 4 5 7 8 9 11 12 16 18
130	19364.	7.404	1.962	1.565	6.185	7.660	9.845	14 3 13 15 1 4 5 7 8 9 11 12 16 18
135	19364.	7.471	1.908	1.487	6.134	7.710	9.853	14 1 8 17 3 4 5 7 9 11 12 13 15 16 18
140	19364.	7.533	1.928	1.508	6.196	7.776	9.942	14 1 8 17 3 4 5 7 9 11 12 13 16 18
145	19364.	7.602	1.951	1.530	6.265	7.848	10.042	1 8 14 17 4 3 5 7 9 11 12 13 16 18
150	19364.	7.677	1.977	1.555	6.340	7.928	10.151	1 8 14 17 4 5 7 9 11 12 13 16 18
155	19364.	7.757	2.006	1.580	6.419	8.012	10.266	1 8 14 17 4 5 7 9 11 12 13 16 18
160	19364.	7.842	2.037	1.608	6.504	8.102	10.390	1 8 14 17 4 5 7 9 11 12 13 16 18
165	19364.	7.627	1.947	1.441	6.452	7.872	10.178	1 7 8 11 4 5 9 12 13 14 16 17 18
170	19364.	7.558	1.952	1.422	6.407	7.806	10.098	1 7 8 11 4 5 9 12 13 14 16 17 18
175	19364.	7.498	1.959	1.403	6.369	7.749	10.030	1 7 8 11 4 5 9 12 13 14 16 17 18
180	19364.	6.585	2.060	1.649	5.561	6.899	8.862	2 5 6 17 1 4 7 8 9 11 12 13 14 16 18
185	19364.	6.491	1.922	1.437	5.440	6.770	8.684	4 5 6 17 2 1 7 8 9 11 12 13 14 16 18
190	19364.	6.411	1.924	1.409	5.373	6.693	8.583	4 5 6 17 2 1 7 8 9 11 12 13 14 16 18
195	19364.	6.334	1.932	1.384	5.309	6.622	8.487	4 5 6 17 2 1 7 8 9 11 12 13 14 16 18

TABLE XXVI (Continued)

TIME(MN)	ALT(NM)	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP	SATELLITES CHOSEN
200	19364.	6.259	1.947	1.392	5.247	6.555	8.397	4 5 6 17 2 1 7 8 9 11 12 13 14 16 18
205	19364.	6.189	1.969	1.440	5.188	6.494	8.312	4 5 6 17 1 2 7 8 9 11 12 13 14 16 18
210	19364	6.122	1.998	1.494	5.131	6.439	8.234	4 5 6 17 1 2 7 8 9 11 12 13 14 16 18
215	19364.	6.059	2.034	1.553	5.078	6.391	8.163	4 5 6 17 1 2 7 8 9 11 12 13 14 16 18
220	19364	6.001	2.079	1.618	5.028	6.350	8.100	4 5 6 17 1 2 7 8 9 11 12 13 14 16 18
225	19364	5.947	2.132	1.691	4.983	6.318	8.046	4 5 6 17 1 2 7 8 9 11 12 13 14 16 18
230	19364.	5.997	2.131	1.778	5.051	6.364	8.125	4 5 8 17 1 2 6 7 9 11 12 13 14 16 18
235	19364	5.939	2.104	1.755	5.001	6.001	8.045	4 5 8 17 1 2 6 7 9 11 12 13 14 16 18
240	19364	5.889	2.080	1.733	4.959	6.246	7.975	4 5 8 17 1 2 6 7 9 11 12 13 14 16 18
245	19364	5.847	2.060	1.715	4.924	6.199	7.917	4 5 8 17 1 2 6 7 9 11 12 13 14 16 18
250	19364.	6.350	1.938	1.421	5.375	6.639	8.542	11 7 8 17 1 2 5 6 9 12 13 14 16 18
255	19364	6.335	1.923	1.409	5.360	6.620	8.518	11 7 8 17 1 2. 5 6 9 10 12 13 14 16 18
260	19364	6.324	1.913	1.401	5.350	6.607	8.501	11 7 8 17 1 2 5 6 9 10 12 13 14 16 18
265	19364	6.318	1.909	1.396	5.342	6.601	8.492	11 7 8 17 1 2 5 6 9 10 12 13 14 16 18
270	19364	6.317	1.912	1.395	5.339	6.600	8.489	11 7 8 17 1 2 5 6 9 10 12 13 14 16 18
275	19364	6.321	1.921	1.398	5.340	6.606	8.494	11 7 8 17 1 2 5 6 9 10 12 13 14 16 18
280	19364.	6.329	1.936	1.405	5.344	6.619	8.507	11 7 8 17 1 2 6 9 10 12 13 14 16 18
285	19364	6.343	1.957	1.416	5.353	6.638	8.527	11 7 8 17 1 2 6 9 10 12 13 14 16 18
290	19364	6.363	1.986	1.431	5.366	6.666	8.557	11 7 8 17 1 2 6 9 10 12 13 14 16 18
295	19364.	6.389	2.023	1.450	5.386	6.701	8.597	11 7 8 17 1 2 6 9 10 12 13 14 16 18

TABLE XXXVII
High Altitude User, Antenna Bwdth = 21.4°

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
1	.070	.00	30.00	55.00	.00	12.00
2	.070	.00	30.00	55.00	126.60	12.00
3	.070	.00	30.00	55.00	233.40	12.00
4	.070	.00	90.00	55.00	42.80	12.00
5	.070	.00	90.00	55.00	160.30	12.00
6	.070	.00	90.00	55.00	269.50	12.00
7	.070	.00	150.00	55.00	83.80	12.00
8	.070	.00	150.00	55.00	193.90	12.00
9	.070	.00	150.00	55.00	310.00	12.00
10	.070	.00	210.00	58.00	123.30	12.00
11	.070	.00	210.00	55.00	230.00	12.00
12	.070	.00	210.00	55.00	355.70	12.00
13	.070	.00	270.00	55.00	161.40	12.00
14	.070	.00	270.00	55.00	270.60	12.00
15	.070	.00	270.00	55.00	44.10	12.00
16	.070	.00	330.00	55.00	198.60	12.00
17	.070	.00	330.00	55.00	315.90	12.00
18	.070	.00	330.00	55.00	89.40	12.00

USER SATELLITE ORBITAL ELEMENTS

19	.816	11.24	47.50	144.21	69.76	11.05

TOTAL TIME(MIN) = 720
TIME INCREMENT(MIN) = 5
BEAMWIDTH ANGLE(DEG) = 21.40
FRACTION OF NAVSAT SPHERICAL AREA = 1.000

ALL SATELLITES, TAKEN FOUR AT A TIME, ARE USED IN
THE CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON

TABLE XXXVII (Continued)

TIME MN.	ALT. NM.	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP	SATELLITES CHOSEN
0	100	1.628	1.289	.922	.707	2.076	2.193	10 1 7 17 5 8 15 18
5	991	.891	1.227	.831	.503	1.517	1.598	15 1 2 3 4 5 6 7 8 10 12 13 17 18
10	1894	.901	1.225	.904	.501	1.520	1.601	15 1 2 3 4 5 6 7 8 10 14 18
15	2774	.719	1.458	1.135	.508	1.626	1.703	15 4 5 6 14 16
20	3612	ONLY	3 SATELLITES ARE VISIBLE.					
25	4408	ONLY	2 SATELLITES ARE VISIBLE					
30	5173	ONLY	3 SATELLITES ARE VISIBLE.					
35	5893	ONLY	2 SATELLITES ARE VISIBLE.					
40	6584	ONLY	2 SATELLITES ARE VISIBLE.					
45	7244	ONLY	2 SATELLITES ARE VISIBLE.					
50	7879	ONLY	2 SATELLITES ARE VISIBLE.					
55	8482	ONLY	2 SATELLITES ARE VISIBLE.					
60	9063	ONLY	2 SATELLITES ARE VISIBLE.					
65	9621	ONLY	1 SATELLITES ARE VISIBLE.					
70	10157	ONLY	2 SATELLITES ARE VISIBLE					
75	10673	ONLY	1 SATELLITES ARE VISIBLE					
80	11170	ONLY	1 SATELLITES ARE VISIBLE.					
85	11647	ONLY	1 SATELLITES ARE VISIBLE					
90	12109	ONLY	1 SATELLITES ARE VISIBLE					
95	12551	ONLY	1 SATELLITES ARE VISIBLE.					

TABLE XXXVII (Continued)

TIME(MN)	ALT(NM)	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP	SATELLITES CHOSEN
200	18947.	ONLY	2 SATELLITES ARE VISIBLE.					
205	19138.	ONLY	3 SATELLITES ARE VISIBLE.					
210	19320.	ONLY	3 SATELLITES ARE VISIBLE.					
215	19493.	ONLY	3 SATELLITES ARE VISIBLE.					
220	19657.	ONLY	3 SATELLITES ARE VISIBLE.					
225	19813.	ONLY	1 SATELLITES ARE VISIBLE.					
230	19961.	ONLY	1 SATELLITES ARE VISIBLE.					
235	20100.	ONLY	0 SATELLITES ARE VISIBLE.					
240	20231.	ONLY	0 SATELLITES ARE VISIBLE.					
245	20354.	ONLY	0 SATELLITES ARE VISIBLE.					
250	20468.	ONLY	0 SATELLITES ARE VISIBLE.					
255	20575.	ONLY	0 SATELLITES ARE VISIBLE.					
260	20674.	ONLY	0 SATELLITES ARE VISIBLE.					
265	20765.	ONLY	0 SATELLITES ARE VISIBLE.					
270	20848	ONLY	0 SATELLITES ARE VISIBLE.					
275	20923.	ONLY	0 SATELLITES ARE VISIBLE.					
280	20991.	ONLY	0 SATELLITES ARE VISIBLE.					
285	21051.	ONLY	0 SATELLITES ARE VISIBLE.					
290	21103.	ONLY	0 SATELLITES ARE VISIBLE.					
295	21148.	ONLY	0 SATELLITES ARE VISIBLE.					

TABLE XXXVII (Continued)

TIME(MN)	ALT(NM)	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP	SATELLITES CHOSEN
100	12982.	ONLY	0 SATELLITES ARE VISIBLE.					
105	13396.	ONLY	1 SATELLITES ARE VISIBLE.					
110	13794	ONLY	1 SATELLITES ARE VISIBLE.					
115	14180.	ONLY	1 SATELLITES ARE VISIBLE.					
120	14552.	ONLY	1 SATELLITES ARE VISIBLE.					
125	14910	ONLY	1 SATELLITES ARE VISIBLE.					
130	15256.	ONLY	1 SATELLITES ARE VISIBLE.					
135	15590.	ONLY	2 SATELLITES ARE,,VISIBLE.					
140	15911.	ONLY	1 SATELLITES ARE VISIBLE.					
145	16222	ONLY	1 SATELLITES ARE VISIBLE.					
150	16521	ONLY	1 SATELLITES ARE VISIBLE.					
155	16809	ONLY	1 SATELLITES ARE VISIBLE.					
160	17087	ONLY	0 SATELLITES ARE VISIBLE.					
165	17353.	ONLY	0 SATELLITES ARE VISIBLE.					
170	17611.	ONLY	0 SATELLITES ARE VISIBLE					
175	17857	ONLY	0 SATELLITES ARE VISIBLE.					
180	18094.	ONLY	0 SATELLITES ARE VISIBLE.					
185	18321.	ONLY	0 SATELLITES ARE VISIBLE.					
190	18539	ONLY	0 SATELLITES ARE VISIBLE					
195	18748.	ONLY	2 SATELLITES ARE VISIBLE.					

TABLE XXXVIII

High Altitude User, Antenna Bwdth = 45°

ORBITAL ELEMENTS

	ECC	ARGP	RASC	INC	ANOM	PER
1	.070	0.00	30.00	55.00	0.00	12.00
2	.070	0.00	30.00	55.00	126.60	12.00
3	.070	0.00	30.00	55.00	233.40	12.00
4	.070	0.00	90.00	55.00	42.80	12.00
5	.070	0.00	90.00	55.00	160.30	12.00
6	.070	0.00	90.00	55.00	269.50	12.00
7	.070	0.00	150.00	55.00	83.80	12.00
8	.070	0.00	150.00	55.00	193.90	12.00
9	.070	0.00	150.00	55.00	310.00	12.00
10	.070	0.00	210.00	55.00	123.30	12.00
11	.070	0.00	210.00	55.00	230.00	12.00
12	.070	0.00	210.00	55.00	355.70	12.00
13	.070	0.00	270.00	55.00	161.40	12.00
14	.070	0.00	270.00	55.00	270.60	12.00
15	.070	0.00	270.00	55.00	44.10	12.00
16	.070	0.00	330.00	55.00	198.60	12.00
17	.070	0.00	330.00	55.00	315.90	12.00
18	.070	0.00	330.00	55.00	89.40	12.00

USER SATELLITE ORBITAL ELEMENTS

19	.816	11.24	47.50	144.21	69.76	11.05

TOTAL TIME(MIN) = 720
TIME INCREMENT(MIN) = 5
BEAMWIDTH ANGLE(DEG) = 45.00
FRACTION OF NAVSAT SPHERICAL AREA = 1.000

ALL SATELLITES, TAKEN FOUR AT A TIME, ARE USED IN
THE CALCULATIONS OF THE VOLUME OF THE TETRAHEDRON

TABLE XXXVIII (Continued)

TIME(MN)	ALT(NM)	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP	SATELLITES CHOSEN
0	99.	1.628	1.289	.922	.707	2.078	2.194	10 1 7 17 5 8 15 18
5	990	.891	1.227	.931	.503	1.517	1.598	15 1 2 3 4 5 6 7 8 10 12 13 17 18
10	1893	901	1.225	.904	.501	1.520	1.601	15 1 2 3 4 5 6 7 8 10 12 14 17 18
15	2773.	.998	1.206	.873	.514	1.565	1.648	15 1 2 3 4 5 6 7 8 10 12 14 16 17 18
20	3610.	.817	1.298	.984	.505	1.534	1.615	5 2 6 15 1 3 4 7 8 10 12 14 16 17 18
25	4409	.837	1.260	.943	.502	1.513	1.594	5 2 6 15 1 3 4 7 8 10 12 14 16 17 18
30	5171.	.868	1.251	.929	.506	1.522	1.604	2 5 6 15 9 1 3 4 7 8 10 12 14 16 17 18
35	5893	.878	1.282	.977	.509	1.562	1.643	5 7 8 16 9 1 2 3 4 6 10 12 14 15 17 18
40	6584.	.956	1.289	1.002	.529	1.605	1.690	5 7 8 16 6 1 2 3 4 9 10 14 15 17 18
45	7245	1.345	1.290	1.012	.649	1.864	1.974	2 5 10 14 11 1 3 4 6 8 9 16 18
50	7877.	1.417	1.595	1.242	.855	2.134	2.299	4 5 8 16 11 1 3 6 9 10 18
55	8482	4.566	1.760	1.249	3.380	4.894	5.947	4 8 11 16 6 1 9 10 18
60	9062	5.059	1.843	1.362	4.075	5.384	6.753	8 11 16 18 6 1 9 10
65	9620	5.425	1.971	1.495	4.445	5.772	7.285	8 11 16 18 6 1 9 10
70	10158.	7.573	2.504	2.015	6.471	7.976	10.270	8 9 13 18 6 1 10 11
75	10672.	7.885	2.639	2.129	6.791	8.315	10.735	13 8 9 18 1 10 11
80	11168.	8.947	2.714	2.260	7.961	9.350	12.280	13 1 8 9 10 11 18
85	11647	9.333	2.540	2.173	8.074	9.673	12.599	1 8 11 15 13 10 18
90	12108.	10.218	2.490	2.125	8.839	10.517	13.738	1 8 11 15 13 10 18
95	12552.	11.205	2.476	2.118	9.705	11.476	15.029	1 8 11 15 13 10 18

TABLE XXXVIII (Continued)

TIME(MN)	ALT(NM)	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP	SATELLITES CHOSEN
100	12982.	11.695	2.525	1.906	10.160	11.964	15.696	8 11 13 15 10 1 18
105	13395.	11.865	2.579	1.982	10.357	12.142	15.959	8 11 13 15 10 1 18
110	13796.	12.067	2.685	2.112	10.590	12.362	16.278	8 11 13 15 10 1 18
115	14179.	19.013	3.589	2.908	17.054	19.348	25.791	10 8 15 18 1 13
120	14551.	11.381	3.024	2.600	10.187	11.776	15.571	10 8 17 18 1 13 15
125	14909.	9.269	2.744	2.213	8.043	9.666	12 575	10 3 17 18 1 8 13 15
130	15255.	9.473	2.801	2.263	8.286	9.879	12.894	10 3 17 18 1 8 13 15
135	15588.	12.188	2.645	1.926	11.098	12.472	16.695	1 3 10 13 6 8 15 17
140	15910.	11.806	2.710	2.017	10.680	12.113	16.149	6 1 3 13 8 15 17
145	16220.	11.760	2.674	1.981	10.660	12.060	16.096	6 1 3 13 8 15 17
150	16519.	11.685	2.666	1.987	10.616	11.985	16.011	6 1 3 13 8 15 17
155	16808.	13.932	3.077	2.501	12.829	14.268	19.187	6 3 13 17 8 15
160	17085.	14.011	3.087	2.489	12.915	14.347	19.304	6 3 13 17 8 15
165	17352.	60.206	5.349	4.950	56.705	60.443	82.878	6 3 8 17 15
170	17609.	51.883	4.118	3.589	48.844	52.046	71.376	6 3 8 17 15
175	17855.	46.409	3.438	2.785	43.688	46.536	63.830	6 3 8 17 15
180	18092.	42.649	3.128	2.398	40.161	42.764	58.665	3 6 8 17 15
185	18320.	40.058	3.080	2.335	37.745	40.176	55.125	3 6 8 17 15
190	18538.	38.304	3.214	2.510	36.126	38.438	52.750	3 6 8 17 15
195	18746.	22.251	3.938	3.319	21.171	22.597	30.965	10 6 8 17 3 15

TABLE XXXVIII (Continued)

TIME(MN)	ALT(NM)	VDOP	HDOP	MDOP	TDOP	PDOP	GDOP	SATELLITES CHOSEN
200	18945.	23.409	4.085	3.516	22.286	23.763	32.578	10 6 8 17 3 15
205	19136.	24.831	4.302	3.786	23.658	25.201	34.566	10 6 8 17 3 15
210	19318.	23.925	4.441	3.896	22.849	24.333	33.380	3 8 15 17 6 10
215	19491.	23.138	4.614	4.061	22.157	23.594	32.367	3 8 15 17 6 10
220	19655.	22.528	4.799	4.237	21.634	23.033	31.600	3 8 15 17 6 10
225	19811.	20.594	3.433	2.606	19.196	20.878	28.362	6 7 10 17 15
230	19958.	341.875	46.747	45.557	323.979	345.056	473.314	15 7 10 12 17
235	20097.	56.623	7.345	7.095	53.253	57.097	78.077	5 7 10 17 15 12
240	20228.	70.332	7.732	7.495	65.957	70.756	96.730	5 7 10 17 15 12
245	20351.	70.881	7.470	7.072	66.489	71.273	97.471	15 5 7 17 10 12
250	20465.	64.260	5.977	5.653	60.280	64.537	88.310	15 5 12 17 7 10
255	20572.	56.847	4.646	4.228	53.378	57.036	78.117	15 5 12 17 7 10
260	20671.	51.973	3.816	3.293	48.862	52.113	71.437	15 5 12 17 7 10
265	20762.	48.747	3.355	2.730	45.897	48.862	67.038	15 5 12 17 7 10
270	20845.	48.179	3.435	2.682	44.882	48.301	65.935	15 7 10 17 5 12
275	20920.	43.780	3.187	2.356	40.728	43.896	59.880	7 10 15 17 12 5
280	20987.	33.440	3.458	2.765	31.441	33.618	46.030	12 7 15 17 5 10
285	21047.	31.097	3.483	2.742	29.244	31.292	42.830	12 7 15 17 5 10
290	21099.	29.216	3.546	2.722	27.485	29.430	40.268	12 7 15 17 5
295	21144.	27.680	3.635	2.703	26.055	27.918	38.187	12 7 15 17 5

Bibliography

1. Aerospace Corporation. "GPS Navstar System Overview." Presented to ASD/EN, Independent Review Team (IRT) for the F-16 GPS/PLSS/EJS Integration, at WPAFB, Ohio, on 29 Jun 1984.

2. Arnold, J. L. and Blank, R. W. "GPS/INS Integration For Range Instrumentation," IEEE 1983 National Telesystems Conference. 226-238. IEEE Press, New York, 1983.

3. Bate, Roger R., Mueller, Donald D., and White, Jerry E. Fundamentals of Astrodynamics. New York: Dover Publications, Inc., 1971.

4. Bogen, A. H. Geometric Performance of the Global Positionin System. TR-0074(4461-02)-2. (Contract No. F04701-73-C-0074). El Segundo: Aerospace Corporation, 21 June 1974.

5. Book, Stephen A., Brady, W.F., and Mazaika, Paul K. "The Nonuniform GPS Constellation," Record of the 1980 Position, Location and Navigation Symposium of the IEEE. 1-8. IEEE Press, New York, 1980.

6. Breedlove, James W. and Euler, William C. "Navstar- Global Positioning System- A Revolutionary Capability," EASCON 81, Record of the 1981 Electronics and Aerospace Systems Convention. 217-224. IEEE Press, New York, 1981.

7. Brogan, W. "Improvements and Extensions of the Geometrical Dilution of Precision Concept For Selecting Navigation Measurements," Record of the 1980 Position, Location and Navigation Symposium of the IEEE. 27-32. IEEE Press, New York, 1980.

8. Chen, Daniel Y. "An Efficient Algorithm For Selecting Optimum GPS Satellites." IEEE National Aerospace Electronics Conferenc (NAECON). 332-348. (1984).

9. Dudzinski, Edward C. Global Positioning System Satellite Selection. Final Report for the period 1 October 1979-30 November 1980 (AFWAL-TR-81-1051). Wright-Patterson AFB, Ohio: Reference Systems Branch, System Avionics Division, Avionics Laboratory. Air Force Wright Aeronautical Laboratories, 2 March 1981.

10. Gilbert, Stephen W. and Parkinson, Bradford W. "NAVSTAR: Global Positioning System - Ten Years Later," Proceedings of the IEEE, 71 (10): 1177-1186. IEEE Press, New York, 1983.

11. Jacobson, Leonard J. "Constraints On the Unlimited Applications of the NAVSTAR Global Positioning System," IEEE 1983 National Telesystems Conference. 431-436. IEEE Press, New York, 1983.

12. Jensen, J. , Townsend, G. , Kork, J. , and Kraft, D. Design Guide to Orbital Flight. New York: McGraw-Hill Book Company, 1962.

13. Jorgensen, Paul. "Autonomous Navigation of Geosynchronous Satellites Using the NAVSTAR Global Positioning System." The 1982 National Telesystems Conference of the IEEE: D2.3.1-D2.3.6. IEEE Press, New York, Nov 1982.

14. Jorgensen, Paul. "Navstar/Global Positioning System 18-Satellite Constellations," Navigation: Journal of the Institute of Navigation, 27 (2): 89-100 (Summer 1980).

15. Kruh, Pierre. "The NAVSTAR Global Positioning System Six-Plane 18-Satellite Constellation," The 1981 National Telecommunications Conference of the IEEE: E9.3.1-E9.3.8. IEEE Press, New York, Nov 1981.

16. Kruh, P. , Brady, W. , and Schmitt, D. "A Strategy For Buildup to the Operational NAVSTAR GPS Constellation," Proceedings of the National Aerospace Meeting of the Institute of Navigation. 43-48. (March 1983).

17. Lamar, Jeannine V. , Rowell, L.N. , and Mate, J.J. Geometric Performance of Pseudoranging Navigation Satellite Systems: A Computer Program. (A Project AIR FORCE Report Prepared for the USAF). R-1949-AF. Santa Monica: The Rand Corporation, July 1977.

18. Milliken, R. J. and Zoller, C. J. "Principle of Operation of NAVSTAR and System Characteristics," Navigation: Journal of the Institute of Navigation, 25 (2): 95-106 (Summer, 1978).

19. Reynolds, James and McCabe, Thomas. "Navstar Global Positioning System," The 1980 National Telecommunications Conference of the IEEE: 21.1.1-21.1.6. IEEE Press, New York, 1980.

20. Sansom, Richard E. "Space Applications of the Global Positioning System (GPS)," The 1980 National Telecommunications Conference of the IEEE: 21.2.1-21.2.3. IEEE Press, New York, 1980.

21. Vaccaro, 1Lt Peter M. Global Positioning System Satellite Selection Evaluation For Aided Inertial Navigation. MS Thesis. School of Engineering, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, December 1983 (AD-A138070).

22. Walker, J.G. Continuous Whole-Earth Coverage By Circular-Orbit Satellite Patterns. (RAE TR-77044). Farnborough, Hants: Royal Aircraft Establishment, March 1977.

23. YEE-81-009. NAVSTAR Global Positioning System (GPS) User's Overview. Los Angeles Air Force Station, California, Deputy for Space Navigation Systems NAVSTAR Global Positioning System Joint Program Office, September 1982.

VITA

Captain David W. Thomin was born on 5 November 1953 in Hamilton, Ohio. He graduated from high school in West Chester, Ohio, in 1972 and then attended the United States Air Force Academy (USAFA) in Colorado. Upon graduation in June 1976, he received a regular commission in the USAF and the degree of Bachelor of Science in Astronautical Engineering. He entered pilot training at Vance AFB, Oklahoma, following graduation and received his wings in July 1977. He then served as an AC-130H Gunship pilot and aircraft commander in the 16th Special Operations Squadron, Hurlburt Field, Florida, from November 1977 to February 1980. Following successful completion of T-38 Pilot Instructor Training (PIT), at Randolph AFB, Texas, in July 1980, he served as a T-38 Talon flight instructor, Assistant Flight Commander, and Assistant Chief Check Pilot for Undergraduate Pilot Training (UPT) students in the 97th Flying Training Squadron, Williams AFB, Arizona, until entering the School of Engineering, Air Force Institute of Technology, in May 1983.

Permanent address: 4291 Princeton Pike

Hamilton, Ohio 45011

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This investigation determined the effect of changes in eccentricity to the orbits of the proposed Global Positioning System (GPS) 18-satellite baseline constellation by analyzing the geometric performance obtained. The effect of satellite losses upon global coverage was also examined with an emphasis on determining which combination of remaining satellites provided the best and worst cases. The potential of GPS for navigation of the space-based user was explored by analyzing the geometric performance obtained for a variety of user trajectories and GPS antenna beamwidths. A computer program which analyzes the many aspects of the geometric performance of pseudoranging navigation satellite systems was used for the analysis.

The results of this analysis indicate that a simple modification to the baseline constellation could reduce outages on a global basis by nearly 50%. The modification consists of changing the shape of the GPS circular satellite orbits to slightly elliptical ones, resulting in more favorable satellite geometry and fewer outages to the user on a global average. Further consideration to determine its feasibility was recommended. The degradation of coverage due to satellite losses was found to be largely dependent on the combination of the remaining satellites, ~~and~~ suggests that the rephasing of the remaining satellites could significantly improve the degraded performance. The potential for conventional use of GPS for navigation in space was shown to exist for the low altitude user, but will be very limited for the higher altitude user due to the present GPS antenna design. Increasing the designed antenna beamwidth was shown to significantly improve performance for the high altitude user. It was recommended that this modification be considered in future GPS antenna design, if conventional GPS navigation is to be desired for the high altitude space user.

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